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INDUSTRIALLY PRODUCED RESOURCE MATERIALS
FOR TEACHERS OF PHYSICS IN SCHOOLS

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INDUSTRIALLY PRODUCED RESOURCE MATERIALS FOR TEACHERS OF PHYSICS IN SCHOOLS

SUMMARY

A questionnaire survey of three groups of teachers who received copies of A Directory of Physics Resource Materials (for teachers, produced by industrial and commercial organizations, Ed. PF Bullett, The Association for Science Education, Hatfield, 1985, pp.22) establishes: the characteristics of the sample of teachers and of their schools; their previous knowledge and use of Industrially Produced Resource Materials (IPRM); the effect of the Directory in encouraging them to obtain further examples of IPRM; their access to and use of audio-visual aids (a necessary precondition for the use of some formats of IPRM); the use of various formats of materials in their teaching; and the means by which they are informed about IPRM.

Analysis of the replies indicates that this non-random sample of 99 teachers was generally aware of, and obtained, very few of the resource materials produced by industrial companies, and these materials largely failed to meet their perceived needs. The findings of two national surveys which are reviewed support these conclusions, and recommendations are made for producers of IPRM.

Case-studies of six successful projects, which used teacher-writers and generated Industrial Resource Material (IRM), identify effective strategies and suggest approaches to future good practice.

The lack of evaluation and effective dissemination of IRM are identified as crucial weaknesses in many current initiatives, and strategies of proven value are suggested which might find application in this context.

A model of curriculum resource diffusion and utilization is suggested as providing a conceptual frame-work for the discussion of teachers' use of IRM and defines critical parameters which would allow measures of both diffusion and utilization in future research.

The historical, economic and political perspectives of the school/industry interface are outlined to provide the context for IPRM.

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KEY TO ABBREVIATIONS

APU	Assessment of Performance Unit
ASCII	American Standard Code for Information Interchange
ASE	Association for Science Education
ASMIT	Applications of Science and Mathematics to Industry and Technology
BBC	British Broadcasting Corporation
BIM	British Institute of Management
BP	British Petroleum
CBI	Confederation of British Industry
CD-ROM	Compact Disc - Read Only Memory
CDT	Craft, Design and Technology
CET	Council for Educational Technology
CLAIRE	County Links Access to Information about Resources and Expertise
CPVE	Certificate of Pre-Vocational Education
CRAC	Careers Research and Advisory Centre
CSE	Certificate of Secondary Education
DES	Department of Education and Science
DTI	Department of Trade and Industry
DoI	Department of Industry
EBS	Educational Broadcasting Services
ECCTIS	Education Counselling and Credit Transfer Information Service
GASS	Gas Applications for School Science
GCE	General Certificate of Education
GCSE	General Certificate of Secondary Education
GDP	Gross Domestic Product
GNP	Gross National Product
HMI	Her Majesty's Inspector
ICI	Imperial Chemical Industries
ICP	Industrial and Commercial Perspective in Initial Teacher Education Project

IEU	Industry/Education Unit (of the DTI)
INSET	In-Service Training
IPRM	Industrially Produced Resource Materials
IRM	Industrial Resource Materials
IT	Information Technology
LEA	Local Education Authority
MSC	Man-power Services Commission
NAIEC	National Association for Industry Education Co-operation (USA)
NCST	National Centre for School Technology
NERIS	National Education Resources Information Service
NFER	National Foundation for Educational Research
OHP	Over Head Projector
OPEC	Organization of Oil Exporting Countries
PGCE	Post Graduate Certificate in Education
SATIS	Science and Technology in Society
SATRO	Science and Technology Regional Organization
SCDC	School Curriculum Development Committee
SCIP	Schools Council/Curriculum Industry Project
SCSST	Standing Conference on School Science and Technology
SEC	Secondary Examinations Council
SEO	Society of Education Officers
SICCI	Schools Information Centre for the Chemical Industry
SIL	School/Industry Link
SILO	School/Industry Liaison Officer
SIS	Science in Society
SISCON	Science in a Social Context
SNIPPETS	Serendipitous Notes in Physics, Physics Education and Technological Sciences
SSCR	Secondary Science Curriculum Review
SSR	School Science Review
SSTF	Southern Science Technology Forum
TES	Times Educational Supplement
TIP	Telecommunications in Practice

TVEI	Technical and Vocational Education Initiative
UBI	Understanding British Industry
VCR	Video Cassette Recorder
WJEC	Welsh Joint Education Committee

CHAPTER 1

EXPOSITION OF THE THESIS AND AN OVERVIEW

The impetus for the research described in the present thesis has its origins in the author's attempt to assemble a collection of resources, produced by industrial and commercial companies, to illustrate applications of physics principles in his teaching within the science department of a boys' secondary school. The difficulties and frustrations experienced, the considerable expenditure of time required to identify suitable materials and the usefulness of some of the items, encouraged the author to make the fruits of this work available to fellow teachers in the form of a published Directory of Physics Resource Materials (BULLETT 1985). An account of the compilation and publishing of this Directory is given in Chapter 5.

Having prepared the Directory, and spoken to a number of teachers informally, the author formed an impression which is the basis for the formal statement of the present thesis.

Teachers of physics are generally aware of, and obtain, very few of the resource materials produced by industrial companies, and these materials largely fail to meet their perceived needs.

The evidence which supports this thesis is summarised in Chapter 8.

It is drawn from a pilot questionnaire study, described at the beginning of Chapter 6, and the analysis of a questionnaire survey of recipients of the Directory, which forms the substance of Chapter 6. These studies alone, based as they were on small, non-random samples, could

provide only preliminary data. A full-scale, national survey, beyond the resources and scope of the present research, would have been desirable to establish the wider validity of the conclusions drawn.

Such a survey was commissioned by a government department later the same year (1985), and was designed to gather information about a number of the concerns which were investigated in the Directory Survey. Unfortunately, its report was not published nationally, and its conclusions only became available to the present author some twelve months later. A critical review of this study, and its implications for the findings of the Directory Survey, is undertaken in Chapter 7, together with a similar review of a series of surveys concerning listening and viewing figures for educational broadcasts, and visual-aid provision in schools, the possession of which is a prerequisite for the use of various formats of industrially produced materials.

IPRM (Industrially Produced Resource Materials) is a term which succinctly describes the materials discussed above (source, DICKER 1985). In order to evaluate the significance of IPRM in the context of the considerable industry/education activity of the past twenty-five years, it is necessary to examine the nature and effect of the various initiatives instituted during the period. This is undertaken in Chapter 4, where it is seen that despite its considerable potential for bringing some experience of industry to all pupils in school, IPRM has generally been given low priority, compared with link schemes and industrial liaison, for example, and few of the initiatives have been successful in moderating teacher and pupil attitudes towards industry, which have often been ambivalent at best.

Running through the "Great Debate", which has characterized the dialogue between industry and education during this period, is the charge that the education system is largely to blame for these attitudes and for the national economic decline. An examination of the historical roots in the 19th Century of the anti-industrial attitudes prevalent in our society in Chapter 2, and the connection between the emphasis of educational policy and economic indicators in Chapter 3, casts doubt on the validity of these charges, while pointing to the role which education could play, together with other agencies, in promoting more informed attitudes.

During this same period, a number of successful projects were influential in bringing applications from an industrial context into school. Six of the most successful are described in Chapter 9 and a summary of the salient points, with suggestions for future practice, is given in Chapter 10. Although industry often sponsored these projects, they were usually organized independently, and the materials they generated are conveniently called IRM (Industrial Resource Materials) to distinguish them from IPRM (see Appendix D.1).

Only one of the projects has undertaken systematic evaluation, which must surely be an important factor in assessing the success of such ventures. Some strategies which could find application in improving the dissemination and summative evaluation of IRM are outlined in Chapter 11.

The role IRM plays in teachers' curricula should be central to any future research study in the field. A model to provide measures of curriculum resource diffusion and utilization, which allows an operational definition of IRM, is described in Chapter 12.

CHAPTER 2

THE HISTORICAL BACKGROUND TO THE "ENGLISH DISEASE"
FROM 1830

The principal concern of the present chapter is to survey the historical influences which have contributed to the prevalence of the "English Disease" and in particular, to examine the role of education.

The characteristics of the disease

Speaking at a conference in 1977, the assistant secretary of the Industrial and Commercial Policy Division of the Department of Industry identified the following: '... the poor "image" of industry, which has led to much of our national talent being syphoned off to other careers; that we have accorded engineers, particularly those working in industry, a lower status than they have attained in other countries; that our society has an inbuilt bias towards the academic and against the vocational, towards "pure" science and against engineering as a technical culture ...; that the cult of the gifted "amateur" has run in industry as elsewhere' (TREADGOLD 1977, p.189). while the government of the day in its discussion paper Industry, Education and Management broadly concurred and additionally pointed to the fact that 'Britain has a two culture system based on the distinction between arts and science, whereas continental society distinguished a third culture in "Technik" (or the art of making things)' and '... has shown more interest and skill in the theoretical aspects of technical advance than its commercial exploitation. Many British ideas have been more successfully exploited by our competitors.' (DTI 1977, p.2.)

Historical roots

As Corelli Barnett pointed out in his much quoted article 'Obsolescence - and Dr Arnold' which appeared in The Sunday Telegraph in 1975 (quoted in WIENER 1981, p.1) 'The "English Disease" is not the novelty of the past ten or twenty years that even informed critics seem to suppose, but a phenomenon dating back more than a century.' It is a peculiarly English phenomenon, '... there is no parallel for it in other industrial nations, all of whom seem successfully to have avoided it ...' and its symptoms are clearly seen in '... our present industrial situation - and the seeming inability of our finest talents to put it right ...' (EMMS 1981, p.7). It has been cogently argued that there are economic reasons for our industrial decline, and the case for this will be examined in the next chapter, but several commentators have identified social and cultural factors which they believe to be of equal significance, and of fundamental importance. David Emms, in his report to The Head Masters' Conference quoted above, observes that '... the malaise appears to spring from deeply rooted insular attitudes, from our unique class divisions, and from the system of education which reflected those attitudes and divisions in the nineteenth century' (EMMS 1981, p.7).

In a wide ranging historical perspective, sub-titled 'Education and the National Malaise' (RAE 1977), John Rae advances the thesis that the roots of our present difficulties lie in the failure of Britain to shuffle off the attitudes appropriate to an imperial power and revert to the characteristics of the 18th century aggressive, successful and enterprising trading state it had once been. Failure was due in part to the nostalgic interest of the old establishment of church and state and the vested interest of the new establishment of organised labour in the status quo. He develops a compelling view that obsolete

attitudes appear to be replaced by new ones. but what appears to be progressive is in truth turning away from reality and a clinging to a world that has passed. The development of his analysis in terms of education will run through this survey.

The nineteenth century

However one may analyse the inter-relation of Empire and the Industrial Revolution, as Martin Wiener has pointed out, 'the industrial revolution in other countries came at least partly from without and this challenged and disrupted traditional social patterns. In Britain, on the other hand, industrialization was indigenous, and thus more easily accommodated to existing social structures, which did not need to change radically' (WIENER 1981, p.7.) so industry and its activities impinged little on the social structure which had evolved for empire and certainly, did not reshape it.

What were the attitudes of those members of society in a position to influence policy? One of Corelli Barnett's main theses (summarised in MACLURE 1986A) is that the attitude of the nineteenth century cultural elite in England was pervasively anti-industrial and anti-commercial, and this was reflected in the educational philosophy of their (public) schools and universities (Oxbridge). As John Rae has remarked, 'the public schools and universities of the late 19th century looked with disdain not only on the world of commerce and industry but on any suggested innovation that might imply that education could be of benefit to that world.' (RAE 1977, p.12.) Even contemporaneous writers such as Mill and Dickens, who were often powerful influences in mobilising the social conscience of that society, ranked themselves against commercial society and as Wiener has pointed out, their rejection '.. was taken up more

explicitly and fervently by younger writers. Arnold and Ruskin ...' (WIENER 1981, p.35.) There is a certain irony that Ruskin, eponymously honoured in the institution from which James Callaghan formally launched the "Great Debate", could write: 'To watch the corn grow, and the blossoms set; to draw hard breath over the ploughshare or spade; to read, to think, to have, to hope, to pray ... the world's prosperity or adversity depends on our knowing and teaching these few things: but upon iron, or glass, or electricity, or steam, in no wise.' (From Works, Volume 5 p.382, quoted in WIENER 1981, p.39.) Indeed, Ruskin College had been founded in 1899 'to provide for working-class students "a training in subjects which are essential for working-class leadership, and which are not a direct avenue to anything beyond". In other words ... intended to give a liberal and not a vocational training' (CURTIS 1952, p.209).

'Industrialization in Britain had, by and large, been achieved with virtually no support from a formal education system. Many of the early pioneers came from nonconformist religious backgrounds, and hence were denied an education in a university.' (JAMIESON & LIGHTFOOT 1982, p.38.) Yet the new generation of successful industrialists might have raised a voice of protest in its own interest, but was largely intent on becoming assimilated into the elite class. This 'gentrification of the new industrialists and the new urban middle classes' was the purpose for which 'the old public schools were reformed and new ones founded' (WHITMARSH 1986). The attitudes of the pupils in these schools will also be seen to have consequences reaching far into the following century. They may be summarised from John Rae's paper as hostility to individual initiative and suspicion of independent thought, a preference for conformity and an uncritical acceptance of the conventional view, and a fierce rejection of external interference,

particularly that of the State (RAE 1977 p.12). These characteristics, coupled with a strong public-service ethic of putting duty and status before financial reward, ensured that the Empire had a ready supply of tractable administrators, even if they were suspicious of innovation and reluctant to implement technical ideas. It could, however, scarcely have been a more disastrous preparation for involvement in industry, or even a sympathetic attitude towards it.

This educational system had its critics. Herbert Spencer wrote in 1861: 'That which our school courses leave almost entirely out, we thus find to be what most nearly concerns the business of life. Our industries would cease, were it not for the information men acquire, as best they may, after their education is said to have finished. The vital knowledge - that by which we have grown as a nation to what we are, and which now underlies our whole existence - is a knowledge that has got itself taught in nooks and corners, while the ordained agencies of teaching have been mumbling little else but dead formulae.' (From Education: Intellectual, Moral and Physical quoted in RAE 1977, p.12.) But he and others were largely ignored.

The series of international exhibitions which were mounted in the second half of the century (Great 1851, Paris 1855, British 1862 and Paris 1867) showed Britain up unfavourably when compared with its rivals, and this led to a strong lobby for 'a more industrially oriented educational system', with Playfair, Huxley, Matthew Arnold and eventually the Devonshire Commission, entering the fray (JAMIESON & LIGHTFOOT 1982). Intervention of the State in the affairs of education was not common in the 19th century, indeed the first government grant of any kind (£20 000 for the 'erection of schoolhouses') was made as late as 1833, but a House of Commons Select Committee,

under B Samuelson (1868), and a Royal Commission, under the Duke of Devonshire (1870), were both established to report on the issue of 'Scientific Instruction'. 'Education reformers ... became obsessed with the need to expand the provision of "science classes", if industry and commerce were to meet "the competition of scientifically trained rivals". Unfortunately, when an expansion of 'science classes' did take place, especially in so-called 'organised science schools' dating from 1872, "there was too much emphasis on the purely academic teaching of chemistry and physics"' (quoted from South Kensington to Robbins by M. Argles in RODERICK & STEPHENS 1981, p.21).

Trading became more difficult, and a Royal Commission set up in 1886 to look into the Depression of Trade pointed to 'Britain's educational defects as being the main cause of her economic problems ... [and stated that] the remedy for evils due to foreign competition was to be found in improved technical education'. (Source, RODERICK & STEPHENS 1982, pp.11-29.) As will be explored in the next chapter, education's being blamed for the country's difficulties in periods of economic recession, was to become a feature of educational debate during the twentieth century.

In summary, the demands made of education in the latter third of the nineteenth century were chiefly specialist science education and technical instruction, an important protagonist body being The National Association for the Promotion of Secondary and Technical Education. Technical education had to fight against classics and the traditional curriculum, and was generally known as 'training in hand and eye', though some favoured a 'more practical and modern curriculum' (REEDER 1979).

For the majority of Victorian children, education was by means of the elementary school, and 'the gulf between

elementary and secondary education, whose perfected form was the public school, was a product of the established correspondence between education and occupation, status and power in English society.' 'The texts of the official Victorian reports on education display detailed attention to assessing and adjusting the supply and content of education to occupational patterns.' Elementary schools' curricula 'became a low-level centrally authorized economy version of liberal education ... with technical education as an optional, but not essential, addition ... a consequence of this was, and is, the arts/science dichotomy which CP Snow later characterised as "The Two Cultures"' (WHITMARSH 1986). Not all children accrued even the benefit of elementary schooling: attendance to the age of ten was not made compulsory until 1880 and school fees were not abolished until 1896 (RODERICK & STEPHENS 1982).

It is an interesting side-light to note that a major critic of vocational training in schools was the Trades Union Congress, which felt it would 'displace learning and operate to the disadvantage of working-class children' (JAMIESON & LIGHTFOOT 1982), a reservation which was to be voiced again during the "Great Debate" of the last third of the twentieth century.

Organized labour was not the only cause of the inertia: social class structure, administration and finance, imperial purpose and the Established Church were all significant factors which militated against the implementation of scientific and technical instruction (GOWING 1978), and as we have seen, the public schools and Oxbridge adopted a moral stance 'inimical to the successful generation of industrial managers', while the grammar schools, who modelled themselves on the public school curriculum, 'ensured that the education system would fail to provide a suitable preparation for technicians and

craftsmen too. ... after 1902 Sir Robert Morant enforced this [curriculum] as the only approved model of secondary education.' (MACLURE 1986A).

The twentieth century and the two World Wars

The major historical event of the first quarter of the century was undoubtedly the "war to end war", and the obvious dependence of the nation upon industry in war caused a gradual shift of focus in the ensuing peace. In a determination that a better society should emerge from the ordeal of war, the so-called "New Jerusalemers" adopted an unashamedly idealistic approach to post-war planning in 1916, yet it originated from concern about skilled manpower and employment. Much of what Britain has lost over the past seventy years stems from its failure to carry into effect plans for day-continuation schools written into the 1918 education act (also part of the 1944 act, and again unimplemented). What killed it was the post-1918 slump and the ensuing financial cuts. (Source, MACLURE 1986A.)

Another consequence of the depression was the establishment of the Malcolm Committee 'to advise upon the public system of education ... in relation to the requirements of trade and industry ...' (MALCOLM 1928 quoted in ROLF 1981). As its report stated, '... the majority of teachers are only too anxious ... that education should be related to the facts and needs of the outside world' (quoted in BECK 1981). But in the general thrust of the report, 'relations between school and industry were relegated to second place behind entry of young persons into employment', and the second report stated that 'a great gulf separated education and industry, and little effort had been made to remove the sources of mistrust on either side' (ROLF 1981).

In the years before the second war, Chamberlain 'recognised

before other leading politicians that England had entered a new and more difficult economic era. ... He offered an activist, urban, industrial version of Conservatism that promoted economic reform. ... His call was rejected.' (WIENER 1981) and the country was soon overtaken by the events of 1939.

From 1944 to the present

As the Second World War was nearing its end, attention again turned to what structures society would need for peace. Sir William Beveridge, the major architect of the welfare state, and RA Butler, in his Education Act of 1944, left what was to be an enduring legacy in important areas of the people's life. Disregarding the contention advanced by Corelli Burnett that '... it should have been obvious from the start that the sums would not add up and that what would get squeezed out would be investment in modernization of industry' (quoted in MACLURE 1986A), for education the major result was the restructuring of secondary schooling on a tri-partite basis, though as has been noted above, the technical schools were never introduced in any numbers, and exercised only a very limited influence. In Guy Whitmarsh's view, Secondary Modern and Grammar schools perpetuated the old distinction between elementary and secondary schools outlined above (source, WHITMARSH 1986), which, as has been observed, were based on the public school model, with some technical training available as an optional extra within the elementary schools.

During the 50s and 60s, Lords Snow and Bowden assumed the nineteenth century mantle of Baron Playfair and Thomas Huxley and railed against the "Two Cultures" society of post-war Britain and provoked wide debate. (Source of comparison, RODERICK & STEPHENS 1981). David Reeder concludes from the reports by DAINTON (1968), SWANN (1968)

and JONES (1967) that 'teachers and academics were "locked up" in their specialisms, producing thereby a group of narrow specialists for the employment market. In the main, representatives of industry were still concerned with specialist education in schools rather than the attitudes of teachers and pupils towards industry'. (REEDER 1979).

It might have been hoped that the further reorganization of secondary schooling along comprehensive lines would have provided the opportunity at last to modify the strong nineteenth century tradition which still gripped education, but John Rae's analysis of the true character of this reorganization is both illuminating and depressing. He identifies the principal educational features of this period as: ending selection at 11+, the discrediting of competition, the provision of the widest choice of subjects to study, and the emphasis on the socialising role of schools. But these reforms he views as 'not reform at all, but an aspect of that self-deception whereby the British cling to the obsolete attitudes of the imperial past'. (RAE 1977, p.13.) He points to the coincidence of: the loss of empire throwing the nation into a harsh, competitive world and the busy elimination of competition in education in all its forms; the need for a curriculum directed towards the specific needs of an island dependent again on its trading success and a wide choice of subjects, including 'soft options', and the disastrous decline of mathematics, science and foreign languages in some schools; when the nation was thrown back on its own resources of talent and ability, schools were doing their best to subordinate these qualities to the less able majority. (RAE 1977, p.13 & 14.) He sees this 'determination to keep intelligence firmly in its place, desire for uniformity, dislike of competition and individuality, preference for subjects on the curriculum that are of no direct utilitarian value to the industrial society, emphasis on the school as a vehicle for

inculcating social attitudes (and) suspicion of government control' as being uncannily close to the 'educational attitudes of Imperial Britain and in particular ... the ethos of the Victorian public schools'. While acknowledging that there are fundamental differences between the two systems, he sees comprehensivization as 'a reinforcement of obsolete attitudes, not a rejection of them' (RAE 1977, p.14).

Whitmarsh's interpretation of the comprehensive phenomenon in terms of his thesis outlined above, has some similarities. He argues that 'comprehensive schools were bound to be a later overlay upon the deeply stratified and long-established educational culture. Its structure was exposed by accusations that comprehensive schools have failed because they have not improved upon the market place pragmatism of the secondary modern school and have undereducated the bright child in a way that grammar schools never did' (WHITMARSH 1986).

From a rather different perspective, Corelli Barnett suggests that there has been a 'failure to devise anything which can be recognized as secondary education for all, even though this was the chosen priority' and that 'all along the best has been the enemy of the good. The "best" in this case, being the elite, university-orientated, GCE O and A level model, and its continuation even after schools were reorganized on comprehensive lines.'

David Emms observes that the "elite" has 'turned ... from public service in the Empire to what Noel Annan has called "the new bureaucracies of higher education, broadcasting, journalism, research organisation, social welfare, planning and the plethora of commissions, committees, boards and regulatory agencies designed to restrain evil and promote virtue" and ... that their ideal of service may be better

realised in the first-order jobs of producing wealth than in the second-order jobs of picking up the casualties of a society which does not produce enough wealth.' (EMMS 1981, p.7.) Though it has been observed that 'The gearing of higher education (in the universities at least) to public service and the professions was at least functional, in the sense that [they] ... were the main recruiter of graduates' (MACLURE 1986A).

In 1980, the Finniston Report (FINNISTON 1980) again observed that 'Culturally, Britain lacks the "third culture" (besides sciences and arts) of the European technik - the synthesis of knowledge from many disciplines to devise technical and economic solutions to practical problems' (quoted in NICHOLL 1982, p.67), despite the fact that government had accepted as early as 1977 that 'industrial objectives may need to be given priority over other policy aims, and that policy in other areas, including education, will need to be influenced by our industrial needs.' (DTI 1977, p.2.)

The policy of the government to education in the late 70s, early 80s, may be characterised as a "back-to-basics" curriculum movement. Guy Whitmarsh observes that it rests 'solidly upon the policy of continuity, namely the restoration and recovery of traditional good practice ...' (WHITMARSH 1986) even though this has been singularly unsuccessful historically in achieving the avowed aim of revitalising industry.

Certainly, the recent initiatives of GCSE and TVEI have given central government more direct influence and control over education, and the work of the APU (Assessment of Performance Unit) has provided wide-ranging, objective evidence of achievement (and lack of it). But as Stuart Maclure has remarked, 'it requires an enormous amount of

optimism to believe that the GCSE is going to put everything right' (MACLURE 1986A) and two sharply contrasting (and basically incompatible) views of the role of education are still current: on the one hand 'a critical force, monitoring social and economic developments' and on the other, 'an adaptive force, matching these developments'. (REEDER 1971.) Though much of the current debate favours the latter, the educational system as a whole seems slow to respond. indeed many within the system have reservations about any uncritical acceptance of that rationale. Besides, as Guy Whitmarsh has remarked: 'the attainment of a higher valuation for British industry is much more a condition for, rather than a consequence of, change in educational policies and practice' (WHITMARSH 1986).

The key to any regime of treatment for this peculiarly "English Disease" would seem to depend on achieving a shift in underlying attitudes in society, from which practical strategies for government, education and industry would flow. Education, equally with the other agents for change, clearly has an important role to play.

CHAPTER 3

THE INDUSTRIAL EMPHASIS OF EDUCATIONAL POLICY AND ITS
RELATIONSHIP TO THE ECONOMYThe suggested pattern of response of educational policy to
economic climate

Several commentators on the pattern of influences and pressures which have directed educational policy during the past 150 years, have observed that 'the power of the "education for industry" lobby is greatest in times of economic recession' (MUDIE 1982) and that 'crudely, when the economy is in boom, there is a tendency to allow education to fulfil the needs of individuals rather than the needs of the economy. In times of economic depression, there are pressures which force all parts of the social structure to conform to the needs of the economy. Education finds itself particularly vulnerable because it is a direct producer of a major and expensive commodity for industry - labour.' (JAMIESON 1985, p.2.)

It may, perhaps, not be particularly surprising that criticism of education by industry becomes particularly vocal in these circumstances, but if the link between economic performance and educational policy can be established, it would cause one to look with a sceptical eye at the common charge that education is responsible for the poor performance of industry and economic recession. A booming economy will have occurred at one and the same time that educational policies are pursued which are judged not to be directed towards industry.

It might be tempting to think in simple terms of "industry" on the one hand, and "education" on the other. In fact, as Beck has pointed out, it is more useful to conceive of a

triangle: '1. academic institutions, 2. industrial trainers and 3. public educators', each mutually influencing the other. Each also has a 'natural' preference for traits which it would like education to possess: '1. "liberal" education (often for a minority?), 2. "economically relevant" studies and attitudes favourable for efficient and reliable workers, and 3. an education relevant to a new and changing society ... but having perspectives which are much wider than just fitting people for different kinds of employment' (BECK 1981). The public educators, who make policy as part of government, are susceptible to pressures from both of the other parties. In times of economic difficulties, they may be predisposed to listen more closely to industry than to education.

Economic profile of performance since 1830

The magnitude of Britain's economic failure has provoked some outspoken comment: 'There has been no failure like it known to the world economic history. The decline of Spain, Portugal, Greece or Venice, in their time perhaps the closest parallels, took over a century in each case to accomplish what we have achieved in thirty years' (S Pollard in 'The British Economic Miracle', quoted in ALDCROFT 1982), and even if 'the question of the causes ... remains beyond the sole grasp of economists' (Peter Mathias in The First Industrial Nation, quoted in WIENER 1981), the fact is indisputable, though it is important to chart the fluctuations over a longer period than thirty years.

In attempting to find a reliable indicator of economic progress and performance, 'income or output per head' (MADDISON 1977, quoted in ALDCROFT 1982) has often been favoured. Three sets of data are illuminating. (Source, ALDCROFT 1982.)

GDP per capita at 1970 prices for the UK compared with the average for all industrialised countries.

	1870	1913	1929	1950	1960	1970	1976
%	143.5	121.8	108.4	112.3	104.8	87.9	84.2

Volume per capita GNP at market prices of the UK compared with Europe.

	1830	1860	1913	1929	1950	1970	1973
%	150.0	188.4	186.5	181.8	180.5	113.7	110.0

Average growth rates of the above compared with Europe.

	1830-1913	1830-1973	1913-1950	1913-1973	1950-1973
%	126.8	85.5	90.2	60.7	51.0

The data suggest that the decline, which is clear whatever measures one adopts, has been subject to fluctuations within the overall trend. 'Only in one period (1929-1950) did the annual growth rate of GDP per capita exceed that for the other countries - 118.2% of the average figure. The most rapid deterioration occurred after the second war, and though it was still respectable in the 1950s, by the 70s it was falling behind' (ALDCROFT 1982).

It has been suggested that recession of the economy has been accompanied by employers and government trying to make education meet the needs of the economy on three occasions during the past 150 years: 'the 1880s and 1890s, the 1920s and the late 1960s and 1970s' (BECK 1981). An examination of the state of the economy and educational policy at these times allows an evaluation of the pattern suggested above.

The 1870s

The following outline description of this period has been given. 'Economic historians agree that British industrial performance declined relative to that of our leading competitors sometime between 1870 and 1900 ...' (RODERICK & STEPHENS 1982.) 'In 1850, the year of the Great Exhibition, Britain was almost exactly at the mid-point of the period at which, it was claimed, she was the "workshop of the world". The period ... ended with the depression of the 1870s. ... During the final quarter of the century, prices fell, factories closed down, unemployment went up and there was widespread distress. ... It would be wrong to assume ... that Britain stagnated industrially ... however, the bare facts of industrial production reveal lower increases in Britain than was the case for her competitors, Germany and the United States. ... The "Great Debate" about Britain's decline was begun by the Victorians themselves.' (RODERICK & STEPHENS 1981.) Statistical evidence may be adduced as follows:

		1880	1913
% of world output	UK	41.4	29.9
of manufactured goods	Germany	19.3	26.5

Between 1889 and 1914 Britain lost £360M in annual manufacturing export, 18% of the actual value in 1913, while Germany gained £330M.

It must be mentioned, however, that one economic historian, SJ Nicholas reviewing 'recent work on British growth and productivity, found little evidence that the economy experienced failure' (NICHOLAS 1985, p.89). The crucial factor is that Britain fell behind her competitors, which was revealed most sharply at the series of exhibitions held in Europe during the second half of the century, as discussed in the previous chapter.

As will often prove to be the case, indications that educational policy was being directed towards industry at this time may be found by reviewing the education reports commissioned by the government during the period. As has been seen, the SAMUELSON (1882) and DEVONSHIRE (1875) reports both placed considerations of commerce and industry in the forefront of their conclusions, even if the influence of the reports in this respect was limited.

The 1920s

There was a severe economic depression in 1920/21, and although there was a revival of production and output, there was a further downturn in 1926. (Source, ROLF 1981.) 'In July 1924, the then Prime Minister ... authorised the appointment of a Committee on Industry and Trade which was "to inquire into and report upon the conditions and prospects of British industry and commerce with special reference to the export trade". This committee, which was chaired by Sir Arthur Balfour, presented its final report in 1929 (BALFOUR 1929)' (COOK 1979, p.52). It commented that 'the process of co-ordination between the educational facilities provided and the ascertained needs of industry and commerce is in several respects imperfect' (BALFOUR 1929, p.28, quoted in COOK 1979).

The Malcolm Committee in its report of 1928, asserted that 'education should, whatever form it may take, be related to the needs and circumstances of life' (MALCOLM 1928, p.53) and commented that 'it cannot be said that educational administrators are in as close touch with trade and industry as they would wish to be at this important stage in educational history' (MALCOLM 1928, p.47, quoted in COOK 1979).

In his article, 'The great debate continues' (COOK 1979), Tom Cook draws many interesting parallels between the concerns and suggested remedies of these two educational reports of the 1920s and those published as background to the "Great Debate" in the 1970s.

The 1970s

If one looks at any one of a range of economic indicators, the economic position of Britain as she moved into the 1970s was very serious. Her ranking in terms of the GDP per capita in the world had in fifteen years plummeted remarkably:

1961	1966	1971	1976
9th	13th	15th	18th

In 1976 productivity (output per manhour working in manufacturing) was bottom of the league in Europe, and as regards wage cost per unit output, only Italy was worse. (Source RODERICK & STEPHENS 1982.) Her 'share of world trade in manufactures declined from 19% in 1956 to 9% in 1975' (TREADGOLD 1977, p.188).

When one examines the long series of educational reports running from the early sixties onwards, an interesting pattern emerges. Three reports in 1963, NEWSOM, BRUNTON and ROBBINS, all talked of relevance, application and the needs of the economy and society, but they were largely ignored. The PLOWDEN 1967 report was "pupil centred" in essence, but a further three reports, JONES 1967, DAINTON 1968 and SWANN 1968, respectively examining the "brain drain", the anti-science swing at university and the flow of scientists, engineers and technologists into employment, were all concerned in one way or another with the needs of

the economy and industry.

Educational debate displayed a certain "bullishness" in the early 70s, with demographic factors combining with a booming economy to create widespread optimism that there would be improvements in the educational system. Owing to the passing through of the post-war "bulge", the growth-rate in higher education fell, and an important element of debate was how one could take advantage of the better pupil-to-teacher ratios which secondary schools were enjoying. The HOUGHTON 1974 report into teachers' pay was able to ignore the falling birthrate in arriving at its recommendations.

The deepening economic crisis in 1973 and the election of a Labour government in February, 1984, marked a watershed for politics, the economy and educational policy alike.

The BULLOCK 1975 report into educational standards struck a note distinctly critical of "progressive" education, which was reinforced by the events at Tyndale School and the ensuing enquiry the following year. The shift of educational initiative from educationalists to government, attention moving from long-term to short-term considerations, the commissioning by the Prime Minister of the "Yellow Book" (DES 1976) from the the Department of Education and Science, and seminally, his speech at Ruskin College later the same year, all indicate the acceptance by government of the case made by the industrial lobby, and its reflection in educational policy. It is interesting to note that many of these concerns had also been those of educationalists, though not exclusively, during the previous decade, but the significant feature is that they became reflected strongly in government policy only when economic circumstances were sufficiently serious to give cause for concern.

This emphasis in educational policy has continued to the present, and indications are that Britain's economic position is still serious, its becoming a net importer of manufactured goods for the first time in 1985 (WHITMARSH 1986). John Rae writing in 1977, drew the comparison between Britain's wind-fall of oil ("black gold") and the gold gained from South America by 16th century Spain, and hoped that '... the British will use the wealth from the North Sea to modernise their industry and use the breathing space the wealth affords to modernise the educational system.' (RAE 1977.) Alas, as the oil revenue begins to wane, there are few signs that either has occurred.

If, as the author has argued, education is not responsible for our economic decline, where does one look? Taken together with the evidence of the previous chapter, it would seem probable that both the failure of our economy and our educational system to meet the demands of an emerging "post-industrial" society stems from national attitudes which have their roots in the imperial role of the last century. A commitment by Government, industry and education towards changing these attitudes is likely to prove crucial for the future economic well-being of the nation.

CHAPTER 4

AN HISTORICAL PERSPECTIVE OF THE SCHOOL/INDUSTRY SCENE
SINCE 1960Rationale

The 1960s may generally be characterised as a period of economic expansion and full employment, with a similar optimism underlying educational policy-making and provision. In the 1970s, by contrast, the economy was in recession, the expansionist policies were reversed and the education system was accused of having failed the economy. A more detailed examination of government policy, the view of industry, educationalists' response and the activities which resulted from the interaction of the three (particularly the role of Industrially Produced Resource Materials) during the most recent period outlined in the previous two chapters, provides the background against which IPRM and the projects described in the case-studies below, have properly to be set.

SECTION 1: GOVERNMENT POLICY

Prior to Ruskin

It is often assumed that the famous speech delivered by the then Prime Minister, James Callaghan, at Ruskin College Oxford on 18th October, 1976 marked the inception by the government of the day of the "Great Debate" in the schools/industry area. While it certainly gave the debate a convenient focus and an impetus which was assiduously maintained through the regional conferences which followed it, educational reports on the one hand, and initiatives by industry on the other, predate both the speech and the "Yellow Book" DES memorandum (DES 1976) which preceded it.

In the early 60s, the Robbins report (ROBBINS 1963) perceived education as a response to the social needs and demands of society, but sought progress by investment in 'human capital' and encouragement of progressive techniques to widen the pool of ability represented, but the reports by Newsom, on average and below average ability students (NEWSOM 1963), and Brunton, on the transition from school to further education (BRUNTON 1963), both talked of 'relevance', 'application' and 'the needs of the economy'. By 1967, the Jones report (JONES 1967) was looking at the 'brain drain' of well-qualified scientists abroad. The swing away from science and technology of students going to university was examined in the Dainton report (DAINTON 1968), while the Swann report (SWANN 1968) showed that the best scientists in the UK stayed in university research rather than entering industry or school-teaching on graduation.

The Bullock report (BULLOCK 1975) marked the completion of a shifting emphasis of educational reports from the philosophical acknowledgement that education should respond to the needs of society in the early 60s, through the analysis of education's failures in the late 60s, to laying the blame for the economic ills of society squarely on the shoulders of education in the mid 1970s. Progressive techniques were criticised, particularly in mathematics and the sciences, and confirmation and "vindication" of this preference for traditional approaches, taken up and amplified in many of the Opposition "Black Papers" commissioned by Dr Rhodes Boyson between 1969 and 1977, was seen to be provided by events at the William Tyndale Junior School in 1976. (For references to several accounts of this episode, including the report of the Public Enquiry conducted by Robin Auld QC, see TYNDALE 1976.)

Industry had also been active. A joint scheme, organized by the Schools Council and the Institute of British Management, for secondment of teachers to local industry was launched as early as 1965, though it is fair to say that it had little impact on schools. The Understanding British Industry project (UBI) of the CBI, the establishment of the Standing Conference on School Science and Technology (SCSST), Project Trident and The Industrial Society were all instigated before the Ruskin College speech. Perhaps one of the most important initiatives, with far-reaching consequences, The Schools Council (later Curriculum) Industry Project (SCIP), had been under discussion for at least eighteen months at that time (JAMIESON & LIGHTFOOT 1982). (For a full account of the purposes behind the project and its inception, see JAMIESON 1985 and TES 1976A.)

From 1975 onwards, the shift in OPEC oil prices forced the International Monetary Fund to impose cuts in public expenditure on the Labour government. This and its precarious majority in parliament, bolstered by minorities, made it particularly susceptible to lobbying by the CBI and the Institute of British Management. Their criticisms of education may be summarised as 1. academic bias, and low esteem of 'the production function'; 2. falling standards of literacy and numeracy; and 3. negative attitudes to work and work discipline due to progressive and permissive teaching (BECK 1981), all of which were reflected, with little modification, in the Prime Minister's speech.

The Ruskin College speech

The Prime Minister's intention was 'to set the stage for a wider discussion of public issues ...' (JAMIESON & LIGHTFOOT 1982, p.13) and to make a rejoinder to the "Black Papers" of the Opposition whom he characterised as '...

those who claim to defend standards, but who in reality are simply seeking to defend old privileges and inequalities' (for a complete text of the Ruskin College speech, see CALLAGHAN 1976B).

In summary, the Prime Minister called for:

wider influence on curricula,
better liaison with industry,
a technological basis in science teaching,
examination reform

and criticised:

the high proportion of girls abandoning science,
standards of numeracy,
new informal teaching methods,
attitudes which were set against industry and
commerce.

A major theme running through his speech was that education was failing to provide satisfactorily for the industrial needs of the country at three levels:

'At a higher level there was a lack of relationship between industry and education. At school level, there was a lack of relationship between schools and working life. At classroom level, there was a lack of awareness among teachers and pupils about the realities of economic life in the modern world.' (KEMP 1985, p.54.)

Specifically, his criticisms of education are illustrated by three representative quotations. 'I have been concerned to find that many of our best trained students ... have no desire to join industry ... there seems to be a need for a more technological bias in science teaching that will lead

towards practical applications in industry rather than towards academic studies.' 'To what extent are these deficiencies the result of insufficient co-ordination between schools and industry? ... These are proper subjects for discussion and debate. And it should be a rational debate based on the facts.' 'To teachers I would say that you must satisfy parents and industry that what you are doing meets the requirements and needs of our children.' (CALLAGHAN 1976A.)

But his vision was rather wider than is often credited, as may be seen from a concluding statement: '[education's role is] to equip children to the best of their ability for a lively, constructive place in society, and also to fit them for a job of work. Not one or the other, but both.' (Quoted in MUDIE 1982, p.72.) He also noted the concern of the chapters above: 'The UK has been in relative economic decline since the beginning of this century. Various reasons for this exist, but the basic underlying reason is the anti-industrialist spirit which pervades our culture.' (Quoted in BES 1983.) He did not hold education solely responsible, but regarded a concerted effort to be essential: '... the achievements of industry and those who work there are often disparaged. ... All in positions of influence, whether in education, the media, trades unions, professional bodies or government, have a responsibility to bring about a change in our national attitudes.' (Quoted from The School Debate by A. Hopkins in JAMIESON & LIGHTFOOT 1982.)

This then was the Prime Minister's analysis: how did he intend that it should be translated into policy? Mrs Shirley Williams, Secretary of State for Education, announced the government's immediate response at Rockingham College of Further Education, Rotherham, eleven days later. 'We intend to embark upon a series of consultations with

the teachers' organizations, the partners in industry and representatives of further and higher education ... to see how to take further the present discussion on the curriculum and on basic skills.' (WILLIAMS 1976). These became the regional conferences, for which a background paper Educating our Children: Four Subjects for Debate (DES 1977B) was prepared. She also announced the intention of establishing a common system of examinations at 16+.

More detail of government policy emerged in various papers and reports from departments, notably the DTI as much as the DES, perhaps reflecting a preference amongst government advisers which eventually led to the abolition of the Schools Council and the provision of funds for capital equipment in schools directly by the DTI. It became clear that the government's "Industrial Strategy" would be given high priority. In the discussion paper Industry, Education and Management (DTI 1977) it was confirmed that '... to turn Britain into a high wage, high output, high employment economy ... the Government have accepted that industrial objectives may need to be given priority over other policy aims, and that policy in other areas, including education, will need to be influenced by our industrial needs.' This strategy was mirrored in the consultative document Education in Schools (DES 1977A) with its 'emphasis on the relationship between schools and the world of work and the underlying assumption that wealth creation is based on the effective applications of science and technology ...' (ASE 1984B, p.37) and the background paper quoted above (DES 1977B) which criticised the lack of contact between schools and industry, and teachers' 'experience, knowledge and understanding of trade and industry ...' (quoted in COOK 1979, p.53).

At a conference in Leeds during 1978 entitled "Shaping Tomorrow", Leslie Huckfield, a Minister in the Department

of Industry, stated '... our aims have been to associate more industrial relevance with the subjects taught in schools, to improve understanding by pupils, [and] teachers ... of industry and its role in Britain ...' and the HMI report Aspects of Secondary Education (1979) expressed 'obvious approval for those teachers and schools incorporating industrial studies of one sort or another into their teaching schemes ...' (both quoted in COOMBES, LAZONBY & WADDINGTON 1983, p.93).

Conservative response and policy

Commenting on the Labour government's green paper in 1978, Norman St.John-Stevas remarked that '... the government had held a Great Debate and felt morally obliged to produce some visible result. ... It paves the way for more centralised government direction of education, [and a] move to "standards" from "structures" as a basis for education' (ST.JOHN-STEVAS 1978). Both his statement of intent and later policies, though he had returned to the back benches by the time many of them were implemented, showed that the approach of the Conservatives in government, as in opposition, on the question of education and industry would be remarkably similar to that emerging from the 'Great Debate' initiated by the socialist government. '[We] need to ensure: a flow of dedicated and highly-qualified teachers, an all-graduate profession, a General Teaching Council, more vocational education, practical applications of knowledge and skills, pupil profiles, careers' guidance, and parents on governing bodies' (ST.JOHN-STEVAS, 1978).

This is made explicit in the first Conservative document A Framework for the School Curriculum (DES 1980) which 'in terms of the educational aims ... is strongly derivative of Education in Schools [DES 1977A]'. One of the seven headings for the proposed structural framework for the

curriculum was 'preparation for adult and working life', while it stressed 'the need to create better links between science, mathematics, and craft, design and technology, and the need for a greater emphasis on the industrial and practical application of science.' (ASE 1984B, pp.43 & 44.)

The School Curriculum (DES 1981) 'in general terms ... represents the conclusion of the public discussion of educational policy initiated by the 1976 Ruskin Speech. It ... promulgates the policy of "science for all" from 5-16 and states that "The increasing importance of science and its applications in the modern world, and the rapid development of technology, reinforce the case for science as an essential component of education ... [which should] command high priority within the in-service training programme ..." ' (quoted in ASE 1984B, p.47).

One of the most significant and often quoted reports of the early 80s was that commissioned by the DTI and chaired by Sir Monty Finniston, Engineering our Future (FINNISTON 1980), which coined the term ' "engineering dimension" to describe "the philosophical outlook towards industry that the British people must acquire", embracing factors which contribute to technological capability and expertise and relating them to industrial strategy and market objectives' (HARTLES 1986). It encapsulated many of the fears and criticisms voiced by representatives of industry at the time, and will be referred to in this context in the next section, but this "engineering dimension" was also an underlying concern of educational policy, as reflected in two documents Technology and School Science (DES 1985A) and Science 5-16 (DES 1985B). In the latter, it was stated that 'Work of the highest quality was observed where the science taught was related to its applications in life generally and where pupils were helped and encouraged to use their scientific knowledge to solve scientific and technological problems appropriate to their age and ability. ... Science

and technology courses should seek to ensure that scientific principles and knowledge are taught in conjunction with technological problem-solving appropriate to the age and ability of all pupils.' (Quoted in DES 1985A, p.28.)

Two major initiatives, too recent to allow evaluation of their long-term significance, have been the government's implementation of a common system of examining at 16+ in the GCSE, and the TVEI initiatives. A survey of the likely contribution of the former is undertaken in the context of an outline model for curriculum utilization in Chapter 12, and of the latter, in a later section of the present chapter, but it may be appropriate to remark here that Sir Keith Joseph, the Secretary of State for Education and a former Industry Secretary, felt that the draft National Criteria for Physics '... fall short of what is required to give sufficient weight ... to candidates' understanding of the technological and other applications of physics' (quoted in McKIM 1983, p.222), and Carol Bailey, Assistant Secretary of the Civil Service and Public Servants Association, has remarked that 'It is no accident that the generous funding of TVEI by the MSC is resulting in more rapid and radical change than previously poorly resourced projects funded through the education service.' (BAILEY 1986, p.11.)

An interesting sidelight may be cast on the realities of educational policy by examining the percentage of GNP spent on education by both Labour and Conservative governments during the period under discussion (source, UK EDUCATION 1986, Table 5 (iii), p.7):

	1965/6	1970/1	1975/6	1980/1	1982/3	1983/4	1984/5
%	4.5	5.1	6.2	5.5	5.3	5.2	5.1

Despite the importance which successive governments have attached to education as an agent of change in improving Britain's industrial health, spending reached a peak in the years of acutest concern, but has fallen steadily since. The percentage spent on education had risen slowly, but steadily, throughout the late 50s and 60s (source, UK EDUCATION 1967, Table 39, p.53):

	1957/8	1958/9	1960/1	1962/3	1964/5	1965/6	1966/7
%	3.4	3.6	3.7	4.2	4.4	4.6	4.9

and the peak was reached the year before the Ruskin College speech (all public expenditure on education as a percentage of GNP at market prices: source, FINANCE & AWARDS 1979, Table 1, pp.2-3):

	1967/8	1968/9	1969/70	1970/1	1971/2	1972/3	1973/4
%	5.1	5.0	5.0	5.2	5.3	5.6	5.6

	1974/5	1975/6	1976/7	1977/8	1978/9	1979/80
%	6.2	6.3	6.1	5.6	5.4	5.3

(N.B. There are discrepancies to one decimal place in these three sets of published figures, probably owing to rounding errors.)

Government continues to be concerned with the role of education in extending the "engineering dimension" to schools, but major funding for developments in the education/industry area continues to be made available through the Industry and Education Unit of the DTI rather than the DES, and the range of its activities is evaluated in the fourth section of this chapter.

SECTION 2: INDUSTRIALISTS' DEMANDS AND CRITICISMS OF EDUCATION

Industrialists speak.

Throughout the period under consideration, industry became increasingly vocal about its perceived needs and the contribution which education could and should be making to meet them. As mentioned above, one of the most influential lobbyists was the British Institute of Management, and a quotation from the report of one of its working-parties is typical of the thrust of industry's demands (BIM, quoted in JAMIESON & LIGHTFOOT 1981, p.39).

'Everyone - and particularly those actually working in industry or industry-linked jobs, and those guiding the attitudes of the young - should understand at least the reasons for the existence of industry, and the essential contribution it makes to the national wealth and therefore to the quality of life in our society.

Understanding cannot be established without clear and accurate information ...'

Education was also the target of specific criticism from other quarters:

'The truth is that most young people leave school politically and economically illiterate' (TUC, in JAMIESON & LIGHTFOOT 1981, p.39).

'... teachers often deliberately or more usually unconsciously, instil in their pupils a similar bias [not to go into industry]' (Arnold Weinstock, quoted in BECK 1981).

Industrialists were not slow in suggesting how improvements

could be effected:

'If we are to prepare today's school children for a highly technological world, then it is important that there is some emphasis within the curriculum on relating the theories and principles of schools' science to modern applications within industry.' (Sir George Jefferson, Chairman BT, quoted in TIP 1985.)

'... there is increasing pressure to bring applied knowledge, in the form of designing and making, much more into the centre of the school curriculum rather than existing simply as an exemplification and extension of theoretical understanding.' (Quoted in DONALDSON 1982.)

but they were also supportive of school science. Several distinguished "captains of industry" accepted the presidency of the Association for Science Education and initiated schools/industry projects, several of which are considered in Chapter 9. Two statements illustrate their concern:

'I firmly believe that these industries [like British Gas] have a responsibility to support and encourage science education ...' (Sir Denis Rooke, quoted in GASS 1982.)

'Industry and education have a joint responsibility to help ensure enough of our best talent goes into science and thence industry.' (Sir Alastair Pilkington, Presidential address to the ASE, quoted in PILKINGTON 1978.)

In a digest of six important reports prepared by a variety

of bodies which were contemporary contributors to the industry/education debate. Jamieson and Lightfoot identify three factors common to them all:

1. there is a premise that British manufacturing industry is declining and that this will lead to problems for the economy;

2. the main source of industry's problems is the unfavourable attitudes held towards it by large sections of the population, with the result that too few young people choose it as a career, and the work-force is apathetic, unco-operative or even hostile;

3. if attitudes are a problem, then education must have an important role in correcting the distortion, sometimes indeed, education is regarded as the source of these unfavourable attitudes (the media running a close second).

There was also an underlying assumption that vocational training was an essential element in education's response, though the report prepared for the regional conferences following the Ruskin College speech (DES 1977B) regarded vocational training as the proper concern of 'further education establishments and of industrial training arrangements' (author's under-lining, quoted in COOK 1979, p.52). The detailed shortcomings they perceived in education are reflected in the specific criticisms outlined in the next section.

Criticisms of education

These tended to fall into two categories: that schools foster the wrong attitudes to industry and that the curriculum does not prepare students for a career in it.

In the same presidential address quoted above, Sir Alastair Pilkington suggests that science education has failed to encourage scientists to permeate society and that it is often thought that a 'science training' restricts one to a 'science career' (PILKINGTON 1978). Even those students who wish to pursue a career in industry, often have the wrong qualifications: 'A significant proportion of those students who say they would like a technological career are unlikely to be equipped with the relevant subjects to fulfil that ambition. Nearly half the survey's pupils ... are studying inappropriate subjects for technological employment should they choose a career in the field.' (PAGE & NASH 1980, p.13.)

Surprisingly, David Emms found that well over half the 180 industrial firms approached in a questionnaire survey had no comment to make about the recruitment of able pupils. He felt obliged to interpret this as giving a profound impression of complacency. He gave a summary of the important, recurring themes in industrialists' replies:

1. far too many young people in the UK go to university;
2. graduates have excessive expectations or require too much expensive re-training if they do join firms after graduation;
3. it is better to take on recruits at 18 and then decide on sponsorship, sandwich courses, etc.: too

many courses have no vocational element whatever.

A selection of quotations from the replies received, illustrates other major concerns and perceptions (from EMMS 1981):

'In all my contacts with local schools I have noticed a lack of realistic understanding on the part of the teaching staff of the facts of our economic life, and an amazing ignorance of the challenges and rewards of manufacturing industry.'
(p.41.)

'Schools should not assume that education cannot be continued outside of an academic environment and so should encourage more young people to enter industry at 16.'
(p.42.)

'Managers are in a sense "generalists" and one of the keys to success is the ability to understand and control a large number of different strands. It is possible therefore that our educational system breeds an attitude which is difficult to change.'
(p.45.)

Industry's criticisms of education may be caricatured as follows: the attitudes of pupils are wrong because they are the victims of a 'vicious circle of teachers encouraging students to the professions and making those who enter industry feel that they have failed in terms of academic success' (JAMIESON & LIGHTFOOT 1982), and the curriculum fails to provide the vocational emphasis industry requires. But what of industry itself; does it bear any responsibility for the attitudes which it decries?

The state of industry

Few would deny that since in the words of the Finniston report 'manufacturing industry, including process industries ... generates 30% of the nation's wealth and employs 32% of Britain's working population' (quoted in BES 1983, section 1.2.1), its good health is a vital factor in the economy. The theory that a service-based solution exists for the UK is generally dismissed (see for example the discussion by Professor Colin New in BES 1983, section 1.2.3), so the importance of revitalising industry is crucially important. Unfortunately, the reality of industry's decline is a potent disincentive to students contemplating an industrial career. As has been remarked, 'real profitability in British Industry is expected to be around 2% this year [1981] - and they [students] draw their own conclusions' (EMMS 1981); they prefer not to join a sinking ship.

There are other factors too. 'British industrial managers are less academically well qualified than their continental counterparts, both as regards the proportion with first and higher degrees (and equivalents) and in terms of vocational relevance.' '... the production function in industry - the management of the manufacturing element of the operation - ... is the Cinderella of management.' 'A CBI sponsored survey ... showed that while most employees appreciated the need for profits and dividends there was widespread misunderstanding of the nature of profits and the belief that profitability is much higher than it actually is.' (TREADGOLD 1977.)

Industrialists themselves have indicated where some improvements might be effected by industry itself. The following is a selection taken from the replies to the Emms survey mentioned above (EMMS 1981).

'... industrialists need to understand better the needs and aspirations of young people and consider to what extent they can be integrated with the objectives of a company;'

'If one thinks for a moment whether a good production engineer of some experience or a chartered accountant specialising in taxation is likely to earn more, the answer cannot be in doubt. If our society chooses to reward the latter from 200 to 500 per cent more than the former, the former's status is inevitably reduced.'

'There are few redundancies in "the professions and the City", and the constant talk of the United Kingdom fast losing its industrial base, is in danger of becoming a self-fulfilling prophecy.'

The two factors of higher salaries and greater status elsewhere are problems to which it is difficult to envisage any short-term solution.

Critique of the rationale for industrialists' criticisms of education

The case for education's having a contribution to make to the industrial recovery of Britain would seem overwhelming. However, reservations have been voiced about the underlying assumptions industrialists make concerning industry's future needs and the role education should play in meeting them, and a review of the important ones is appropriate.

The accusation of lower standards of entrants to industry was often based on a lack of appreciation that industrialists were drawing from a different population as

more young people stayed longer in the education system, particularly in the climate of falling youth employment from 1976 to 1980. There were contradictions: schools were accused of encouraging pure science, which was contributing to the nation's economic decline, and at the same time both industry and universities preferred entrants with these qualifications; although the content of Technology syllabuses were more relevant to industry, it preferred O level Physics; and the Mode III status of CSE maths for industry examinations made employers suspicious. The attitudes of young people were regarded as crucial to discipline, punctuality and the ability to carry out orders etc. on the one hand, and to preparing for life with the accompanying social skills, on the other, without questioning to what extent the two objectives might be mutually incompatible. (Source, JAMIESON & LIGHTFOOT 1982.)

In placing the responsibility for students' attitudes towards industry on their teachers, there is a surprising confidence that teachers are more influential than the media, parents and peer groups; the view that teachers are a remarkably homogeneous group, more so than (say) "managers" or even "engineers" seems unlikely; and the assertion that attitudes towards industry derive from lack of understanding about it, which in turn derives from lack of information, is open to doubt. If these assumptions are ill-founded, the charge that education is responsible for the poor attitudes students have towards industry is seriously undermined, while not exonerating education from a responsibility to try to change these attitudes for the better.

A radical critique of the case for industry's influencing education to move in the directions outlined above has been advanced which questions both the substance of industry's arguments and its motivation. Whilst taking an extreme

position, it indicates that the assumptions which predicate industry's position should not be accepted uncritically. In an article entitled Education for Industry (EDGLEY 1977), Roy Edgley disputes the assumption that 'modern industrial development requires an increasingly skilled workforce whose educational demands have outstripped the abilities supplied by schools, colleges and universities' (op.cit. p.27) and suggests that 'employers seek to employ, and pay for, workers with more education than they need ... as an agent of subordination to established authority.' (op.cit. p.31.) He founds his argument on research in the United States, which perhaps mirrors our future as they are further along the road to a "post industrial" society, and comments that '... industrial skills ... [which] require no active intelligence, can be learned in four or five weeks or less, and are properly exercised without conscious attention. It would be difficult to imagine anything less capable of providing criteria of quality in education' (op.cit. p.29). He concludes that '... the so-called "gap" between industry and education is in fact an "inconsistency" between education and occupation' (op.cit. p.32). This is to paint his case in the broadest of brush-strokes, and it does scant justice to either the detail or subtlety of his arguments, but it is a case which industrialists would do well to consider and to answer, for in the process they would arrive at a clearer understanding of what their real needs might be, now and in the future.

Finally, it is instructive to quote two pieces of advice to industry given by educational reports written some fifty years apart:

'... employers should make themselves familiar with what the schools are doing now so that they may better understand how to evaluate the skills and experience pupils acquire in schools' (DES

1977B, p.13).

'Industry must define their needs and no other body can do it for them, but if such definition is to be of any use it should be based on a reasonably full and sympathetic knowledge of what schools are doing and are trying to do.' (MALCOLM 1928, p.10.)

SECTION 3: EDUCATIONALISTS' RESPONSE AND PROPOSALS

Introduction

Education is confronted with a fundamental philosophical question concerning its role when faced with the demands of industry outlined in the previous section: should it be "critical", of social and economic developments within society, or "adaptive", responding to the needs and dictates of the society it serves? Of course, it is possible (and desirable) for it to fulfil both roles, but the wisdom of allowing education to meet 'the needs of society', as argued by Professor DJ O'Connor in an article 'Two Concepts of Education' (O'CONNOR 1982), is questioned by RM Jonathan (JONATHAN 1982), (JONATHAN 1986), at least in the glib way the argument is often presented. The debate is not new, although its context has changed. 'The choice, on the one hand, between a curriculum geared towards useful knowledge and, on the other, one enshrining the values of the "liberi" or freemen, was faced fairly and squarely by Aristotle nearly 2 500 years ago' (BRENNAN 1977, p.99). This tension between 'vocational' and 'liberal' education is often implicit in the response education has made, described in the sections below.

Response to the "charges" of industry

As Carol Bailey has remarked, 'the debate itself is symptomatic of broader pressures on our educational system, with Government, local authorities, employers and parents seeking to place new responsibilities and new demands on schools in general and teachers in particular - often burdens that employers and parents were once expected to pick up. ... Schools which have for years been struggling without proper funding can be forgiven now for feeling frustrated that their earlier efforts were for so long incapable of being fulfilled, while the new direction in the curriculum awaited funding from outside the education service [the DTI and MSC].' (BAILEY 1986, p.11.) There has also been the reduction in the funding of education noted in Section 1 of this chapter, and this has hampered change, particularly with a background of high youth unemployment. 'The cut-backs in teacher provision and public spending on education make any changes in educational practice more difficult: it is difficult enough to maintain the status quo. And the question "Are you teaching about the world of work?" would be answered in many staffrooms by a further question: "What work?" ' (JAMIESON & LIGHTFOOT 1981, p.51).

One of the most cogent criticisms following the Ruskin College speech was of falling standards, but despite the economic background outlined above, Sir James Hamilton, delivering the 26th Graham Clark Lecture to the Council of Engineering Institutions, remarked: '... it is, I believe, fair to suggest that these trends [examination results] argue against the kind of major deterioration in performance which is all too often imputed to schools by their more virulent critics' (HAMILTON 1982, p.6). Even if standards have been maintained, there remains a problem of structure within the total educational system which

militates against its achieving a balanced curriculum which includes vocational training, a pattern which is almost universal in the rest of Europe. 'The fact is that most other countries don't just have a different curriculum - they have much more education, so that it is quite possible to combine a general education with appropriate forms of professional training' (MACLURE 1986A).

Despite the economic and organizational difficulties which education faces, there is a willingness in many quarters to respond positively to the challenge of meeting the needs of contemporary society. This commitment by the Society of Education Officers is typical of many: '... when so much attention needs to be given to the regeneration of the economy of this country, the relationship between education and industry and the question of the support that education may give to economic development should be explored and developed.' (SEO 1983, p.2.) It has been suggested that an integral part of the educator's job should be 'to help the employer identify the abilities he needs,' (TREADGOLD 1977, p.192), but one difficulty in changing the curriculum to foster these abilities, is the educational philosophy of 'categories of knowledge and understanding' which has underlain the evolution of the curriculum during the 70s and early 80s. 'These categories have come to be associated with traditional school subjects ... one practical consequence has been the simple updating of what used to be called "a liberal education". The corollary is that any curriculum approach which stresses "fitness for life" ... becomes automatically suspect.' (BRENNAN 1977, p.100.)

Vocational education

The most significant development of recent years in this area has been the introduction of TVEI (Technical and Vocational Education Initiative) and the framing of the

CPVE (Certificate of Pre-vocational Education), but anxieties have been expressed about some of the consequences of these schemes. '... We are confronted with the unpredictability of the labour market, uncertainty about the permanence of industries, and consequent doubts about introduction of vocational courses lower down the age range even as the effective age for leaving education or training is raised. ... What is a developing cause for concern is the persistence of undiluted academic programmes for the abler pupils side by side with the growing adoption of pre-vocational courses for the lower half of the ability range.' (LLOYD JONES 1986.)

An author involved in a TVEI project within physics has written: 'my worries with TVEI are that education may soon be viewed only as training for a job and that education and training as synonymous. ... As the Royal Society said in their report Science is for everybody: "... we need to get across the fact that the scientific bases for decisions are often overridden by economics, environmental issues, ethics, social issues, employment, aesthetics, diplomacy, the power of big industry and the defence of freedom." I do not think an appreciation of these comes from training. Being able to make decisions about them does not either. ... I am concerned by the parents who endorse TVEI just from the point of view of it helping to get their child a job. ... TVEI's principal benefit ... is that of fostering financed curriculum development. It has got science, in some places, using modern instrumentation, it has brought in real life problems and situations, it has taken education outside and brought the outside into schools, ... in many places [it has] brought class sizes down to those commonly found in technology and home economics.' (BUTLIN 1987.)

There is also disquieting evidence from the United States

of America (GRUBB & LAZERSON 1981) of the failure of a vocational emphasis in education to meet the economic requirements of employers, and this perhaps lends support to teachers who, like the one quoted above, welcome the advent of a vocational, or at least an applied, element in school science, without accepting industry's directly utilitarian rationale.

Science teachers' attitudes and concerns

In a series of reports which span the 70s and 80s, the Association for Science Education, as one of the most influential bodies representing science teachers, has consistently advocated making science more relevant to everyday life and embracing more closely the related discipline of technology. Science and general education (ASE 1971) '... emphasizes the need to link science studies to everyday life and to applications. ...' (ASE 1984B, p.33). Science for the 13-16 age group (ASE 1973) '... suggests that the Association would create a means for discussing "in depth the place of technology within education in general and within science education in particular" ' (quoted in ASE 1984B, p.34), in Alternatives for science education (ASE 1979A) 'the third ... part of the paper seeks to develop an alternative rationale for the science curriculum that meets current needs better. ... the third model representing a full integration of scientific, social and technological aims and contexts.' (ASE 1984B, p.39), and Education through science (ASE 1981) 'defines as an aim of science education "... the attainment of a basic understanding of the nature of advanced technological societies, the interaction between science and society ..." and further suggests that the science curriculum can be explored from the viewpoint ... of "science and its applications: the development of an appreciation and

understanding of the ways in which science and technology contribute to the worlds of work, citizenship, leisure and survival ..." ' (quoted in McKIM 1983).

It will be noted that the motivation for these recommendations is improving the effectiveness and relevance of science, not primarily preparing children for future employment. Science teachers recognized, in the words of the Director of the SATIS (Science and Technology in Society) project, that '... students are far more motivated towards science when it is linked to familiar, everyday things - food, medicine, transport, communications - than when it is about academic theories' (HOLMAN 1986) and is likely to provide the majority of pupils with a sounder preparation for life beyond school.

The way forward?

A remarkably wide range of commentators are agreed that one of the acutest problems besetting our education is the form of the examination system post 16+ and the route to higher education. 'Viewing the contrast with continental practice, and the educational "equipment" of an able French or German 18 year-old or graduate, I can draw no other conclusion than that our three A level pattern lies at the base of our industrial difficulties as far as inadequate management is concerned.' (EMMS 1981, p.36.) 'One submission [included in the Finniston report (FINNISTON 1980)] pointed to the dichotomy which exists between (i) the expressed requirements of industry for people with the capability to apply knowledge and with the personal qualities of motivation, leadership, drive and stamina, and (ii) the actual, and usually exclusive, requirement for academic purity for entry into further and higher education, and even into industrial training, on the way to industrial employment.' (EMMS 1981, p.11.) '... it is important that

all young people, including the most academic, are encouraged to gain broader standards of education than those currently measured by O and A levels' (Robert Malpas, quoted in HARTLES 1986). 'The WJEC, like many other bodies, has expressed its disappointment at the parsimonious view of access embodied in the recent Green Paper Higher Education into the 1990s, and questioned whether access should be provided so exclusively through the O and A level route.' (LLOYD JONES 1986).

The philosophy behind the government's proposals for AS levels, announced in May, 1984, received widespread support when they were launched (see the list of employers, professional bodies and those responsible for higher education in DES 1987), though there are indications that particular university courses will continue to specify closely-linked specialist combinations of subjects, and that the broadening effect intended is likely to be much diluted, lacking as the proposals do any requirement to choose across traditional subject groupings. Moreover, the timetable projected originally is already behind schedule (see DES 1984, p.8). In the light of this initiative, it would seem that more radical proposals, such as five A levels, or a pattern similar to the International Baccalaureate, are unlikely to receive official attention in the foreseeable future.

If the pattern of education for potential graduates and managers is felt to be unsatisfactory, there has been a strong call from within the education profession itself for a shift in the emphasis of the education provided for all to the age of sixteen. In an occasional paper entitled Key issues for industry and education (SEO 1983), the Society of Education Officers advances a perspective of education which encompasses 'Education for Enterprise', 'Technological Capability' and 'Information Technology'. In

the words of the introduction, the paper 'asks questions ... it does not prescribe solutions' (SEO 1983, p.2), but it represents a detailed and tightly-argued analysis of the issues, and one of the strongest 'pro' statements written from the educator's point of view, though perhaps lacking a certain balance. It advances the case that the first priority in compulsory schooling 'is to create the conditions in which, from an early age, children and young people can begin to understand and appreciate the value and challenge of business enterprise ... [and acquire] attitudes, skills, knowledge and experience which as well as being of general educational value have a special role in "Education for Enterprise" ' (SEO 1983, p.3). It calls for a moderation of the present imbalance between 'education' and 'training', and suggests that 'education must be much more strongly oriented towards giving individuals the capacity to be autonomous, self-supporting and self-directing in appropriate contexts' through the medium of Information Technology (SEO 1983, p.3).

Finally, two quotations seem to point the way forward if some of the suggestions of this section are to stand a chance of implementation. 'While those of us in education can claim that the fault surely does not lie entirely with the educational system, what we cannot do is pretend that there is no case to answer' (KEMP 1985, p.54). 'There is no point in attacking the teachers: it is not their fault. And besides, any hope of rescuing education from its own malaise depends on building them up, not knocking them down' (MACLURE 1986A).

SECTION 4: SCHOOL/INDUSTRY LINKS AND OTHER INITIATIVES:
THEIR EFFECT UPON PUPILS' ATTITUDES TOWARDS
INDUSTRY

The idea of giving children some experience of the world of work while still at school is not recent. The Malcolm report in 1928 cited evidence which indicated that there existed at the time 'a favourable attitude towards visits to factories and other places of business - "Such are, indeed, a natural part of the arrangements for relating the curriculum to [the] occupational environment" ', and more recently, Educating our children (DES 1977B) 'alludes to the significant contributions that might be made by employers and trade unions by offering opportunities "for work experience and work observation" ' (both quoted in COOK 1979, p.54). School/industry activities during the period under review have sometimes appeared to concentrate predominantly on pupil visits to industry, but how effective have these visits and the many other initiatives been in informing children about industry and creating favourable attitudes towards it, and what has motivated industry to take part in these activities?

Industrialists' motivation for taking part in SILs

The Industry/Education Unit of the Department of Trade and Industry has explained its, and by implication industry's, policy of encouraging school/industry links in the following terms: 'our main concern is that everyone, and especially young people at school, should gain a better understanding of manufacturing industry, both with regard to its important contribution to the country's economy and standard of living, and to the diversity of interesting and challenging careers there. We have, therefore, devoted most of our effort to encouragement of local links between schools and companies and a fair amount of activity is now

taking place' (a personal communication, quoted in LEAFE 1986, p.146).

In A critical examination of the case for linking schools and industry (STYAN 1986), David Styan suggests that industry takes part in the variety of SIL activities to 'secure a future labour force, promote their products or services, polish their local and national reputation for caring about the whole environment and the communities therein, raise the standards of consumer awareness and become better understood', while schools 'see industrial links as providing employment opportunities, motivation (especially in those who are most likely to regard schooling as childish), relevance and realism, resources, understanding and recognition of the achievements and difficulties of teaching' (STYAN 1986, pp.8 & 9). So links may operate to the mutual benefit of education and industry, but there are potential dangers for education: its purpose may become distorted, industrial links may not be compatible with the balanced development of the individual, not all school leavers will enter industry, many of the materials and resources are given "with strings attached" and staff do not always approve of what amounts to firms taking the pick of the leavers.

Gerald Lloyd has suggested a complementary list of reasons for industry's willing involvement: 'undisguised philanthropy, pride of achievement, enlightened self-interest, the development of a supportive society, and a need for the recruitment of the necessary workforce ...' (LLOYD 1984, p.130).

In certain circumstances, some of the same motivations can also be reasons why industry declines to be, or stay, involved. In discussing employers' liaison with schools, it has been observed that '... teachers have been approaching

local employers with increasing frequency with requests for usable and appropriate discarded equipment and old journals and so on ... one company, however, was particularly anxious not to appear to be shoring up a low level of educational spending on equipment by assisting in this way ... it felt ... that it should not become involved in educational provision which is the proper responsibility of the LEA' (BALL & GORDON 1985, p.22), and the economic recession in some areas has meant that 'many firms no longer have much of a recruitment problem, and this would appear to have been the major reason (though not the sole one) for the participation of many companies in schools-industry work' (JAMIESON & LIGHTFOOT 1981, p.50).

Some within the teaching unions are fully committed to the concept of school/industry links, indeed Alf Wilshire of the NUT is quoted in an article in Education as avowing 'we have fought with all means at our disposal to build bridges between schools, industry and work' (WILSHIRE 1976, p.326). As hinted above, however, there is a position critical of these links. Roy Edgley has written: 'as education inevitably establishes links with industry, many teachers and students ... will resist the cosmetic operation being planned, and will insist on raising the question "Education for industry, or - in its present form - against it?"' (EDGLEY 1977, p.32).

The variety of school/industry activity

A wide range of initiatives has taken place, the most important of which are summarised in A Guide to a Schools/Industry Project (PHYSICS AT WORK 1980B):

- pupils' visits to industry,
- creation of resources,
- visits to schools by industrialists,

sponsorship of competitions,
 extended visits or secondment to industry for
 teachers.

to which has been added 'twinning' of an individual school with a local company (for example DAVIES & FOREMAN 1982), holiday attachments, 'Young Enterprise' schemes, 'twinning' with a group of local firms (EMMS 1981, pp.30 & 31) and industrial fellowships for teachers (for example, BP 1981).

A number of projects and posts has either been created to facilitate an interchange between schools and industry, or made this an important part of their activities: The Schools Council/Curriculum Industry Project, UBI (Understanding British Industry), The Industry/Education Unit of the DTI, The British Association for the Advancement of Science, The British Institute of Management, SATROs, SILOs, the CRAC insight programme, the SCSST, Project Trident, Education for Industrial Society, The Royal Society of Arts with Industry Year 1986, and many others.

Many industrial companies, particularly the multi-nationals, have had active education services, responding to enquiries from education, producing information and teaching materials (the concern of the following four chapters), arranging teacher secondment and local work experience, providing industrial fellowships, sponsoring INSET diplomas for teachers in the industry/education area and arranging conferences for sixth formers and residential conferences for teachers and industrialists. (Details of the activities of three such companies may be found in articles in View: BP 1981, ICI 1981 and UNILEVER 1982.)

Some of these activities have been criticised as

ineffective. and sometimes counter-productive. An industrialist observes: '... there is a tendency to show industry to pupils solely through the factory visits and what they see is a plant churning out products. They do not see the industrial system, the work that has gone into getting the products right, finding the markets, into providing the money to build the plant and the people to run it. They will not understand from a plant visit the importance of profit, the relationship between industry as a creator of wealth and the education system that provides its talent ... there should be much more preparation before plant visits so that pupils understand more the significance of what they see' (PILKINGTON 1978, p.600). There are other difficulties too. 'Industry will not allocate anywhere near the sums necessary to promote proper link schemes', 'personnel officers don't carry enough guns - or money!', 'schemes fizzle out when there is a change of personnel' and schools which are situated in the NW or SW, often find the absence of local firms prevent their establishing links, as do schools in major conurbations with their 'impersonal and fragmented industrial structure' (EMMS 1981, p.29).

One charge is that they are not cost-effective: 'one worrying feature of school/industry liaison is that vast sums of money are being spent on projects, with little or no evidence that they are likely to bring about successful attitude development ... it might have been useful to channel some of that money into determining which lines of action were most hopeful' (REID 1980, p.80), and sometimes have little genuine impact on schools: 'industrial liaison is sometimes a substitute for curriculum change' (JAMIESON 1985). Possible schemes for the evaluation of Industrially Produced Resource Materials are explored in Chapter 11, and the need to change attitudes in the next section. For a fuller appraisal of the case for school/industry links, see

STYAN 1986.

The need is to change attitudes

It might be thought in the light of the lack of evaluation of attitude development and the apparent comparative failure of some initiatives outlined above in this respect, that the fostering of positive attitudes to industry was regarded as a low priority, but as these quotations show, this was far from the case. 'The key to the definition [of school/industry liaison] lies in two phrases: informed attitudes and all pupils' (REID 1980, p.78), '... [recent reports] see the source of many of industry's problems as lying in the unfavourable attitudes held towards it ...' (JAMIESON & LIGHTFOOT 1981, p.39), 'all in positions of influence ... have a responsibility to bring about a change in our national attitudes' (James Callaghan, quoted in JAMIESON & LIGHTFOOT 1982 from The School Debate by A.Hopkins), 'there is a particular need for action at school level, where attitudes are formed and where foundations are laid for future careers' (BATES 1980, p.82), 'the main obstacles to be overcome are the poor 'image' of industry (not always undeserved)' (DTI 1977, p.2), '... the moulding of attitudes is as crucial as the teaching of facts in helping to determine the directions that people will take' (PILKINGTON 1978, p.592), '... we can [tackle issues] ... at a purely factual level, but must encourage pupils to consider values and attitudes as well' (DES 1977A, p.55).

These last two quotations highlight an important assumption which is implicit in many school/industry initiatives; that if information is provided or exposure to industry is arranged, pupils' attitudes will become more positive. A review of the limited research which has been carried out in this area causes one to question this view.

Evaluation of SILs and other initiatives

One of the few surveys and evaluations of school/industry link schemes was that by Sir Neville Cooper in 1981, in a report commissioned by the DES (COOPER 1981). 24 national institutions were selected for the survey from over 164. The Secretary of State for Education and Science invited comments on the report in September, 1981. In a written answer to a Parliamentary Question on 26th July, 1982 he made little reference to individual comments and there was, unfortunately, 'little evidence that much flowed from the Cooper report' (KIRTON 1984), despite some detailed recommendations, and its influence was disappointing.

A recent set of materials produced for the School Curriculum Development Committee under the general title Education for work and edited by Ian Jamieson, promises a detailed review, though it was not published in time for the present author to examine it. Work experience workbooks: a critical review (SCDC 1987B) is concerned with work experience initiatives and Industry in education: developments and case-studies (SCDC 1987C) covers the full range of industry/education initiatives, including SIL's, teachers into industry schemes and industrial managers as a resource for INSET. One hopes that these materials will reach a wide audience and go some way to identifying and confirming the ineffectual aspects mentioned above and suggest strategies for improving them, as well as commending good practice.

The impression conveyed by the few accounts of foreign practice is that industry and education work together more effectively than in the UK and that there is less contention about the role of the education system. 'Many of the activities planned for Industry Year 1986 are an

extension of the influences I observed in the USA when I spent a period there a few years ago ... I was most impressed by the way the Americans handle co-operation between these two areas [business and educational establishments]' (LEAFE 1986, p.145) and in a reference to the HMI report of Education in the Federal Republic of Germany. Reg Hartles indicates that 'having commented upon the considerable contributions of effort and money which are made by teachers, officials, parents and employers, the report adds: "ultimately, however, the system works because virtually everybody involved seems determined that it should' (quoted in HARTLES 1986, p.287). There would appear to be some advantage in examining continental practice and attitudes in some detail from the perspective of school/industry liaison.

In a research study into Teenage attitudes to technology and industry (PAGE & NASH 1980) the authors undertook a survey of attitudes amongst 14-year-old pupils and made case-studies of twelve schools with high attitude responses. They identified the following common factors in the case-study schools: 'good academic results, good discipline, good parental contact, low staff turn-over, adequate consultation over subject options, strong science and CDT departments, Nuffield-type courses, school clubs, and strong relationships with employers' in other words, they were 'good' schools 'in ways suggested by the HMI report Ten good schools (1977)' (op.cit., p.12). The observation that in these schools 'there seems to be a growing receptivity on the part of staff to the idea of pupils, including the brightest, going on to technological careers ... in some schools such ideas resulted from increasing awareness, probably gained from the media, ... whilst in other schools, teachers' attitudes seemed a consequence of greater understanding of industry, developed through contacts with industrialists, e.g. by

school-industry liaison schemes' (op.cit., p.13) would seem to suggest that liaison schemes are only one factor, and perhaps not a crucial one, in developing attitudes. Further research in this area would be illuminating.

The impression that is conveyed in most of what has been written about school/industry activity, is that the great majority of it has little impact on student attitudes. Two studies of the influence of industrial teaching materials in changing attitudes, (REID 1980) and (COOMBES et al. 1983), are more optimistic and perhaps point a way forward. They are reviewed in the general context of Industrially Produced Resource Materials of the next section.

SECTION 5: THE INCIDENCE AND ROLE OF IPRM

(INDUSTRIALLY PRODUCED RESOURCE MATERIALS)

Comparatively little mention is made in the reviews of school/industry activity of resource materials, probably because many are concerned with liaison and links at local level, and the majority of IPRM has been generated by national or multi-national companies, but there is also the suspicion that its potential has not been fully appreciated. What is industry's motivation for producing these materials?

Rationale for companies producing IPRM

Two companies, ICI and BP, which have made significant contributions in the area, have advanced the following as their reasons for doing so: 'the company is heavily dependent on good science and research, and has long appreciated the need to support and encourage a high standard of science teaching with all kinds of back-up

materials, and regards:

portraying industry as a worthwhile place for youngsters to spend their working lives in, influencing school curricula, to make them more relevant to the needs of industry, and engendering a better understanding in schools of how wealth is created, what manufacturing industry contributes to the prosperity of the country and to give schoolchildren some idea of what work is all about.

as important goals' (ICI 1981, p.4):

'to support project work in schools,
to respond to a large number of requests for information about BP from pupils and teachers,
to support BP staff who want to link with education - they need something with which to start,
to illustrate applications,
to support INSET,
to produce long term changes in attitudes of teachers and students,
not for recruitment or to boost product sales,
to lead the way in showing industry what educational support can be.'

(A member of Educational Relations BP, quoted in ANSELL 1987.)

It is seen that many of these objectives overlap with those advanced for school/industry liaison in general, but tend to be more specific. Many are altruistic, in that they are intended to improve the quality of education in a general sense, which can only represent a long-term benefit for

industry.

The advantage of IPRM

The advantage of IPRM, compared with other possible approaches to school/industry liaison, has been well outlined in the context of teaching materials produced by the chemical industry. '... Attempts at school/industry co-operation must face up to the inevitable logistical restraints. A local industry cannot cope with mass visits from thousands of secondary pupils. School timetables cannot afford repeated dislocations. Such restraints often mean that factory visits are only feasible for small numbers, usually of academic, older pupils who are sometimes determined largely by timetabling considerations. Another way of approaching school/industry contact is through project weeks. However, over the whole of the country, these involve a few hundred pupils, and the exercise is relatively expensive. Published materials can reach much larger numbers, and films and audiovisual aids can be used extensively ...' (REID 1980, p.78). In some areas this strategy has been used to get over some of the logistical difficulties described above: 'one or two authorities, regarding as unrealistic the possibility of pairing all primary schools with firms, are developing curriculum materials ...' (LLOYD JONES 1986).

But to regard IPRM only as a substitute for industrial visits or "twinning" is to fail to appreciate its considerable potential. The following is taken from one of the few reports to make any comment about IPRM. 'The use of educational resources produced by industry and commerce is one very valuable way to ensure coverage by the curriculum of important aspects of modern industrial society. ... It is no good producing materials on banking, insurance, food, textiles, oil, chemicals etc. and making these available to

schools without matching them carefully to curriculum needs and also without being able to evaluate their usefulness.' (LEESON 1982.) The emphasis is on influencing the curriculum, and '... pupils' attitudes are more likely to be influenced when their studies are seen by them to have relevance to industry. This is achieved most readily when mainstream courses themselves have direct reference to industry' (LLOYD JONES 1986).

The potential of IPRM and IRM to affect attitudes

There has been widespread acceptance amongst educationalists of the need for science to be related to the world outside the laboratory and to illustrate everyday and technological applications of principles, particularly in an industrial context; the thread runs through many of the significant reports by the ASE concerning science education outlined in the third section of this chapter. The case is put cogently in the teachers' guide to SATIS, a seminal curriculum project in this area, sponsored by the ASE, which produced IRM (Industrial Resource Materials): 'surely, if there is one thing science education should be doing for the citizens of tomorrow ... [it] is to equip them with the means to consider such issues [the manifestations of science and technology in society] in a rational, informed way ... abstract concepts will be of little use unless their relation to practical applications is made clear ... adolescents find the science they are taught dehumanized, and irrelevant to themselves and their lives ... but [are] attracted to the idea that science can be useful to society.' (SATIS 1986, pp.13-15.) These are educational arguments for this approach; it motivates students and prepares them to understand the world in which they are to live. One "aim" of the project is 'to develop an awareness of industry, its economic basis, how it operates and its role in wealth creation' (SATIS 1986,

p.17). This goes much of the way to meeting industrialists' requirements for education outlined in the second section of this chapter, but there is no mention of attitudes. The implication seems to be that students will become aware of industry, arrive at an understanding of its role in society, and the negative attitudes towards industry which they are widely believed to hold will be modified in the process. Of course, to include the promotion of positive attitudes towards industry as a specific objective might prove contentious, though some other initiatives have been less circumspect. As will be seen later, many of the teaching approaches advocated by SATIS, such as role-play, discussion and working in groups, have the potential to be effective in moderating attitudes.

A piece of research which looked at the inclusion of case-studies from the chemical industry in Israeli chemistry education concluded: 'pupils have changed their attitude towards the chemical industry as a result of the course ... they are more interested in industrial matters ... most reported that this was the first time they had realised that the chemistry taught in school had any relevant applications!' (NAE, HOFSTEIN & SAMUEL 1982, p.21.) The case studies required students to explore alternative strategies, often using pilot experiments, and simulated a 'real' situation. In a study based in this country on the consequences for students' attitudes of an emphasis on industrial topics in an O level chemistry course, it was reported that 'whereas there was general support (from both teachers and pupils) for the need for this emphasis, there was little evidence that it increases interest in, and motivation towards, chemistry or careers in industry. The inclusion of the wider social and economic aspects did not meet with student approval and thus the inclusion of such topics must be justified in more general educational terms.' (COOMBES, LAZONBY & WADDINGTON 1983.)

The difference between the two studies, apart from geography and that one was conducted at the post 16+ level, the other pre-16+, was that in the former, students were placed in a position of taking decisions in a context very similar to that from which the case-studies were drawn, while in the latter, industrial topics were introduced in apparently much the same way as traditional topics, though the report does not give any details of precisely how they were presented. That the difference in the resulting attitudes of the students may be attributed to the different approaches adopted to the industrial topics, is borne out by another study of the impact of industrial teaching materials in chemistry courses.

The rationale for introducing industrial topics is succinctly expressed. 'Educationally, all pupils need to appreciate the industrial, wealth-producing basis of our society ... the details of a particular process will be largely irrelevant, except to those who work on the process, ... but all pupils need to appreciate why industry is the way it is, and how it is likely to develop. Industry involves human beings, it has human and technical problems, it has to make decisions, and it may appear heartless in its effects on humans and the environment. Such aspects of industry need to be understood, so that pupils can be informed (but not manipulated) in their attitudes to industry ... traditional forms of education/industry liaison will contribute little to the development of such informed attitudes ... it is unlikely that pupils will develop attitudinally merely by having information poured into them.' (REID 1980, p.78.) The paper goes on to outline the three phases of the model adopted.

1. Teaching material related to the chemical industry can be presented in an interactive way. By interactivity, a process of deep involvement is envisaged.

Interactivity is often visible to an observer, as pupils are seen to be arguing and discussing.

2. An invisible process, which could be called intraactivity occurs, and in this process, conflicting fragments of information are mentally battered around in the pupil's mind. Sometimes new information confronts previously held attitudes. Somehow the pupil tries to build up a self-consistent picture.

3. Intraactivity can often produce internal conflict, which has been described as dissonance. It appears that attitude change can be mediated by dissonance.

'It is not simply a case of teaching industry and informed industrial attitudes; it is a case of allowing pupils to interact with industrial situations, allowing them to accommodate the information for themselves' (REID 1980, p.79).

Two large experiments, involving some 1 100 pupils, were established to evaluate the effect of the packages on pupils' attitudes. '... clear, positive results were obtained indicating that pupils who had been exposed to the packages had demonstrated increased industrial awareness when compared with pupils who had not used the packages, though the latter group had studied the same chemistry. ... Some advantages of this system can be listed: the materials are cheap to purchase, dovetail to an existing syllabus and are short; they require no factory visits (with timetable dislocation) and no teacher-training, which means that large numbers can benefit; they make no attempt to "sell" industry or an industrial career; they are strongly pupil-oriented, requiring minimal teacher preparation.' (op.cit., p.80.)

Reid does not claim that the model represents the only approach, but suggests that the interactive teaching package is one of a number of useful strategies teachers might adopt in 'teaching towards attitudes'.

Multi-media resource packs

An initiative which has some parallels with the teaching packages discussed above has been undertaken within the School of Education at the University of Bath. Its purpose is also to give large numbers of students the knowledge which is acquired by direct access to industry, but through teaching materials. '... a few experienced people with knowledge of schools and school-teaching [are] ... given the support of industry/commerce and access to its skills and expertise. These individuals then put the knowledge they have acquired in a form that as many teachers as possible will find acceptable in their classrooms. ... If a considerable number of teachers and learners are to be helped by the material, there is no way that an arbitrary decision can be made as to the teaching style that must be adopted. The availability of multi-media resource packs ... gives this freedom of choice.' (LLOYD 1984, pp.130 & 131.) An evaluation of the use of such a pack, BP's 'A North Sea Adventure' has been undertaken (SCOTT & LLOYD 1979), though its potential for affecting student attitudes has not been monitored. This approach will be reviewed further in the context of general advice for producers of IRM in the summary of the selected projects undertaken in Chapter 10.

CHAPTER 5

A DIRECTORY OF PHYSICS RESOURCE MATERIALS

Background and rationale for the Directory

The stimulus for the compilation of a Directory of resource materials produced by commercial and industrial organizations which were relevant to teachers of physics in school, had its origins in the difficulty which the author experienced in assembling a quite modest collection of such materials for use in his own teaching. This was attempted because of the general educational philosophy, outlined in Chapter 4, that children in full-time education should be aware, amongst other things, of the relevance of their school studies to the day-to-day technological and engineering challenge of production industry and should recognize that science does not exist in isolation from its applications. Physics was perceived by many pupils to be "academic" and lacking relevance, while industry's use of physics principles through technology was largely unknown, because the applications of principles given in physics text books were mostly old-fashioned, simplistic, "low-tech" and lacking in the immediacy to be gained by quoting examples drawn from contemporary processes in industry.

A good deal of material had found its way into school by somewhat haphazard routes, but much of it was out of date, too general and not in a form or format which enabled its direct use in teaching. Several of the larger multi-national companies produced good material, but the emphasis often reflected their involvement with chemical processes and manufacture, and was sometimes blatantly commercial or promotional. The author subsequently discovered that a survey carried out by the Council for

Educational Technology found that much of the materials was produced by public relations staff for advertisement (GOULD 1987). It seemed that a systematic survey of what was available would be necessary to find the materials relevant to physics and to provide illustrative examples referring to a wide range of physics principles.

To avoid reduplication of effort and to cast the net as widely as possible, it was decided to request catalogues and materials directly from commercial and industrial organizations and to contact learned societies and umbrella organizations for industry and science education. Also, since the assembling of catalogues and the identification of material seemed likely to involve considerable time and effort, it was deemed sensible to try to make the results of such research available to a wide audience in the form of a Directory and if possible, to assemble a collection of suitable material for inspection by teachers. The collection would clearly have to be housed centrally and be available at times when teachers might be able to consult it. The Department of Science Education, University of Warwick, was approached through Dr PA Screen and it was readily agreed that such a collection could be housed in the Department where both student teachers and those who use the library as external borrowers would be able to consult it. In due course a collection of materials was assembled in the Westwood Library and this was eventually supplemented by a large collection of resource materials from Understanding British Industry, an organization described below.

IDENTIFICATION OF PRODUCING ORGANIZATIONS

In February, 1982 the process of identifying organizations which produce materials of possible relevance to teachers

of physics in school began.

Audio-visual Catalogues As a first step, an inspection of various catalogues and a collection of teaching materials (relevant to all disciplines) which were held in the audio/visual unit at the University of Warwick was carried out. The most seminal catalogue was that of The Foundation for Visual Aids. Although many organizations were rejected as apparently producing no relevant material, where there was any reasonable doubt, the company was placed on the list to be contacted. All materials produced by publishing houses or stocked by commercial film libraries (unless directly commissioned by an industrial concern) were excluded. This was necessary both to keep the survey within manageable proportions and also because such organizations advertise their materials very widely, and teachers are likely to be aware of what is available from direct 'mail shots' and from exhibitions in school and at conferences, such as the annual meeting of the Association for Science Education.

UBI A formal approach was made to the Resource Centre set up by the Confederation of British Industry under the project entitled 'Understanding British Industry'. As a result, a visit was made to the Centre in Oxford in April of 1982. Their collection of materials to date inspected and a booklet entitled Teaching Materials obtained (UBI 1979). This had been prepared in March, 1979, though an updated version was available as the collection was being catalogued and the information placed on a data-base. Although the booklet was directed to all teachers in school, irrespective of discipline, a careful selection of material had been made with regard to its relevance, conceptual demands and linguistic level. It listed 101 addresses which could be contacted to arrange speakers and visits or to obtain catalogues and materials. Each entry

was annotated to give a clear account of what was available and for whom it could be suitable. About 40% of the entries indicated that there could well be resource material suitable for physics teachers and these addresses were added to the list.

In addition to specific sources, several non-industrial organizations were listed at the end, including SICCI (Schools Information Centre for the Chemical Industry), and NCST (The National Centre for School Technology).

On the same visit, reference was made to an annotated manual of audio/visual materials dealing with physics topics to be produced by the Institute of Physics and this was pursued.

The Institute of Physics and the Association for Science Education The two professional organizations concerned with teachers of physics in school were contacted to establish their contributions in this area and knowledge of existing sources.

The IoP confirmed that an annotated directory along the lines planned by the author had been initiated, and some materials collected from industrial sources, but that it had not been continued because staffing and finance were not available at that stage. Ms Beverley Madge, the Education Officer responsible for initiating the project, was very helpful in providing the author with material which the Institute had collected to date and this enabled the net to be cast very much more widely.

The ASE referred to several projects to generate 'industrial' materials which it was sponsoring, and indicated that it would be interested in fostering a Directory of industrially produced resources, and might be

prepared to undertake publication in due course.

NCST This organization was contacted, and in response, their resources Directory was supplied (NCST 1976). Besides containing references to material of common relevance to Physicists and Technologists teaching in school, the line-printer format suggested that a computer system had been used in its compilation and items were listed by format within a given syllabus topic, with a guide to age-range and cost. About one third of the syllabus topics seemed to list material relevant to Physicists, though references were made to material available from commercial film libraries which were specifically excluded from the intended Directory of Physics Resources.

The Compiler, Dr CJ Pratt of Trent Polytechnic, confirmed that a computer had been used in the printing of the Directory, but mentioned that the items were not stored on a data-base, so updating was a major undertaking and for this reason, had not been attempted since 1976 and would not be attempted in the foreseeable future. Several elements of "sound practice" in the production of such a directory were apparent and these were to be important guidelines in the formulation of structure and format of the Physics Resources Directory at a later stage.

Industry/Education Unit of the DoI It was suggested that an approach be made to Dr EB Bates, Head of the Industry/Education Unit at the Department of Industry, to obtain a list of the members of the "Industrialists' Panel". These company representatives are active at the industry/education interface and between them have considerable experience of teaching resources in an industrial and technological context. Some 19 of these members were added to the circulation list, only those whose responsibilities seemed mostly for recruitment or

personnel being excluded. Dr. Bates passed a copy of the letter requesting information about industrially produced materials to Dr FR McKim, Director of the 'Physics Plus' project.

'Physics Plus' This project, aiming to develop a course in physics plus its applications for use in school up to 16+, was sponsored by the Standing Committee on Schools' Science and Technology. The writing of double-sided A3 leaflets was undertaken by pairs of industrialists and science teachers, assigned geographically where possible and concentrating on specific, and usually single, industrial processes which illustrated an application of a physics principle. As a result of this contact, the author attended a valuable one-day conference at the North London Science Centre when many of the implications and practical issues of illustrating applications in physics teaching were discussed, including the possible future role of examinations for encouraging their use. Eventually, the 'Physics Plus' materials were published by a commercial house, so were excluded from the Directory under the self-imposed limitations of coverage, though the project seemed so important, that it was later included as one of the case-studies described in Chapter 9.

Science advisers and the Schools' Council Finally, in this initial stage of the exercise, the Science Advisers to two Local Education Authorities were approached to request copies of the Schools/Industry Links directory which authorities had been asked to prepare as a result of the national SIL initiative. These were not forthcoming, presumably because they had not been completed, but an enquiry to the Schools' Council about a survey of LEA/Industry links resulted in the reference to a directory for the Leeds Education Authority. Nearly all the entries referred to opportunities for visits, visiting speakers and

work experience. Virtually no local company produced material which it volunteered for use in school. Since this source revealed so little relevant information, it was decided not to pursue this line of enquiry further.

CIRCULATION OF COMPANIES AND THEIR RESPONSE

By the end of 1982 a list of some fifty companies (see Appendix A.1) had been established as a result of exploring the sources described above, and a "launch" was organized at the annual meeting of the Association for Science Education at Manchester University via the medium of a "poster display". As the chief purpose of this launch was to try out a pilot questionnaire, it is described in greater detail in the chapters dealing with the survey questionnaire below.

Important indications to emerge during the course of the two days were firstly the encouragingly high level of teacher interest in and enthusiasm for the initiative, and secondly, that teachers were unable to recommend materials or sources of materials which they felt should be in the Directory from their personal experience which were not already included in the list of fifty companies. The poster display was visited by about 200 members of the Association and since conversation indicated that these were on the whole well-informed and enthusiastic protagonists for the greater inclusion of applications material in teaching, it seemed that the initial list of companies included at least those which were best known to many science teachers.

A letter explaining the establishment of a library of materials and requesting information under seven headings (see Appendix A.2) had been dispatched to the companies on the list late in 1982, and through the first six months of

1983 responses began to arrive.

The delay and relatively low response rate (c.60%) highlighted one of the most difficult and persistent problems concerned with gathering industrial material: making sure that one's enquiry arrived on the correct desk. In the case of the large multi-national companies, addresses from which material should be sought were clearly shown in the catalogues and other materials they distribute and all such dealings were centralised in their 'Education Section', often at their London head-quarters. In the case of smaller organizations, the administration of requests from schools and others were dealt with variously by their library, press and publicity office, personnel department and research and development groups and often, each division within the company was autonomous in this respect and did not always forward requests to divisions which might have provided relevant material. Unilever represents a company where this system obtains, but where the London headquarters fulfils a co-ordinating role (UNILEVER 1982, p.12), but it is the exception.

A study conducted by the Council for Educational Technology on behalf of the Industry/Education Unit of the DTI in 1985 concluded that '... teachers wishing to discover learning resources to meet specific requirements are faced with pursuing their enquiries through an unco-ordinated array of individuals, formal agencies and informal associations at local, regional and national level. Not only is this job time-consuming, it is hit-and-miss: firstly because teachers have no way of being sure they are calling upon all likely sources of assistance; secondly, because these sources do not always have systems capable of handling a regular flow of routine enquiries' (quoted in TAYLOR 1986).

A second problem when requesting material for inclusion in the Directory was the universal anonymity of replies. This meant that following-up offers of material, or submitting entries in the Directory for correction, was difficult.

In the event, only five companies sent materials as a result of the first letter, perhaps because they were unsure which of their materials were relevant for inclusion in such a Directory (!) or the material concerned was not available free of charge. The most common response was to send the current catalogue and suggest that a selection of the material be made and the organization contacted again. The companies which did respond with materials did so generously, and four of the five were amongst the best-known producers of educational materials and were apparently well-funded educational sections of multi-national companies.

About the same time, an advertisement (IoP 1983) requesting suitable industrially produced material was placed in Physics Bulletin, a journal of the Institute of Physics with a wide circulation amongst physicists in industry. (It is included as Appendix A.3). As far as could be judged, this did not result in any organization submitting materials. This was possibly because the readership is largely among the technical staff who are not directly involved with the preparation or publication of educational materials. Were one seeking the donation of materials in 1987, Snippets a publication of the Institute of Physics described in a case-study in Chapter 9, and View, a publication of the IEU of the DTI would be obvious places to advertise.

PRODUCTION OF THE DIRECTORY AND COMPUTERIZATION

It quickly became apparent that the potential volume of entries likely to be included in the final Directory, and the desire to retain the option of further editions, made it desirable to establish a computer database to contain the information.

Initially, a microcomputer disc-based system (BBC-B) was explored, but in order to achieve the flexibility in sorting and file-handling of a large database, the system had to be capable of carrying the entire file in RAM and the capacity of the BBC machine without a second processor was too small. Also, there was no existing data-base package for the BBC which had the flexibility of variable length fields and the full suite of facilities in printing format which would be desirable.

In May 1983, an approach was made to the Computer Unit of the University of Warwick for technical advice as to the system which would best meet the above requirements, bearing in mind the eventual publication of the data-base in the form of a Directory. The recommendation was to adopt a database package much used in bibliographic work, a version of which was available for the main-frame computer at the university, a Burroughs B6700 at that time.

The structure of the data-base

FAMULUS provides a basic frame-work for systematically sorting, manipulating, searching, indexing and printing bibliographic data. Information is entered for each "record" under a number of "fields", each of which is represented by a four-letter label. There is then considerable flexibility as to how this data is manipulated and presented. The technical details of how the package is

run are not immediately relevant to the present study, but the field structure adopted had to be carefully designed to allow for future entries and the ready accessibility of data.

To contain the information summarised by the seven points listed in the letter circulated to publishers (see Appendix A.2) 14 fields were established:

INDX a number, representing the syllabus section under which the entry would be listed, necessary for non-alphabetical sorting.

SYLL section name, corresponding to the INDX number.

TITL the title of the material.

YEAR year of publication, if known.

DESC a brief description of the contents of the item, if not clear from TITL.

AUTH the name of the author or editor.

FORM the format of the item.

REFN publisher's reference number, ISBN etc.,

AGER recommended or identified target age-range or audience, expressed as quantum numbers chosen from 5,8,11,13,16,16+ or 'teachers',

COST unit cost or free loan etc.,

PUBL the name of the company or division responsible for publication.

DIST the name of the distributor if different from PUBL, e.g. a film library.

ADDR the address from which the item could be obtained.

RE VW reference to any review of the item in School Science Review or Physics Education.

A standardized format, set of abbreviations, etc. was established and two spare, "dummy" fields were left (DUMB and DUMC) so that other categories could be added at a later stage if necessary. FAMULUS structure demanded this.

The choice of headings for the SYLL field posed certain problems. It was clearly desirable for there to be many sub-divisions so that teachers could locate items relevant to a particular piece of teaching quickly and accurately. on the other hand, too many would make the Directory cumbersome to use and lead to numerous double entries. A compromise of eleven headings was chosen originally, though the numbering given here is that adopted subsequently (see below):

- 110 Mechanics
- 120 Heat
- 130 Molecular Properties
- 140 Waves
- 150 Light
- 160 Sound
- 170 Electricity and Magnetism
- 180 Electronics
- 190 Energy and Radioactivity
- 200 Applications
- 210 Professional Materials

Headings 170, 180 and 190 were subsequently sub-divided as follows:

- 172 Electricity (AC): transmission, applications and safety
- 174 Electricity (DC): circuits, electrostatics and instruments
- 176 Electromagnetism
- 182 Electronics: history, production and development
- 184 Electronics: theory
- 186 Electronics: practical work
- 192 Radioactivity: atomic physics, radiation and detection

- 194 Radioactivity: history, commercial processes,
power supply and safety
- 196 Energy: conversion and resources

Pilot Study

In order to gain familiarization with the package and to ensure it met the demands of the Directory, some twenty test items were entered into the base using the CANDE (Command and Edit interactive system for the B6700) operating system via a terminal in the Work Room of the Warwick Computer Unit. After some initial "teething problems" the system seemed to work well, though the numbering system adopted for INDX had to be modified subsequently as the FAMULUS package sorted 'quasi alphabetically' rather than using the more normal numerical criterion.

It also became evident that entering a large number of items, using a system which had very crude editing facilities and did not readily allow the duplication of field-specific information (such as the recurring address of a supplier) from one record to another, would not be very efficient. The unit could provide data-processing by clerical staff, but the information had to be transcribed from the materials onto pre-coded forms, so the labour involved did not seem to justify the gain in convenience of not having to spend time at the Computer Unit or transport the materials. To allow working away from the Computer Centre, the telephone modem link system was considered, but the baud rate was low, so telephone charges became prohibitive, even if the system was not used interactively, but just to transfer data.

After a meeting with four of the Computer Centre's

programmers, it seemed desirable to devise a way of creating a data file away from the University, and then transferring it into the Famulus package in large batches. A program had already been devised to allow the transfer of ASCII code files to the Burroughs from a BBC tape-based machine and it seemed that it would not be problematical to adapt it to disc. However, the writing of the BASIC programs to create the original ASCII file would have to be undertaken by the author, though the unit promised support and technical help.

The advantages of such an approach were clear. Data could be entered as and when materials arrived and the main-frame computer would only have to be used to enter the data in batches, say once a month, to manipulate the database and to print the results. The software to allow the creation of files on a BBC-B machine and their transfer from disc to a Burroughs B6700 main-frame computer, perhaps inevitably, was not easy for an inexperienced writer and before undertaking the considerable investment of effort to produce them, it was decided to gain a firm commitment to publication from the Association for Science Education.

Funding and publication of the Directory

The Association for Science Education had indicated that it would be willing to meet the cost of publication of the Directory, but could not fund the preparation expenses and so in March of 1983 an application was made to the Institute of Physics for funds under its "Small Grants" scheme. These are intended for the support of initiatives by practising school teachers and although a major part of the work demanded the use of a University computer facility, the results of the work would be of direct benefit to school physics teachers and a grant was duly made in June, 1983. A formal approach was then made to the

Association for Science Education, and a rough draft using some twenty sample items and a high-quality print-out on a "Qume" printer was requested by their Publications Committee.

The sample Directory was submitted in October and was accepted, subject only to one or two recommendations: the further subdivision of syllabus headings outlined above, the inclusion of date of publication for each entry where possible and the clearer spacing of information within an entry by semi-colons between fields. A publication date for the completed Directory was tentatively agreed for June, 1984, the last mailing for advance publicity for this dead-line being January, 1984. A technical limitation on the weight of this mailing prevented the adoption of a "before" and "after" questionnaire comparison which had been proposed originally.

Computerised entry of items to the Directory: software and hardware

In the first six months of 1984 replies were received from companies approached in a second mailing of the letter (see above) in December, 1983 and from various sources which had been contacted subsequently. It was a characteristic of industrially produced materials that they were often publicised piece-meal and in a wide range of publications.

The process of devising the software for preparation of an ASCII file of items on the BBC-B machine was begun.

Specific features were important in its design:

1. There should be automatic cueing of field labels to save time.

2. a fixed upper limit should be placed on the length of descriptions given under field DESC (69 characters),

3. it should be possible to duplicate quickly the contents of fields PUBL, DIST, ADDR etc. from one record to another, to save time when entering a large number of items from a single company,

4. the records should be recorded to disc frequently, to reduce the possibility of corruption or loss,

5. the syllabus section headings recorded under SYLL should be called up from a data list by the program, both to reduce time and to ensure that the syntax of each heading corresponding to a given INDX number should be identical: an important consideration, as a sort routine was to be carried out by FAMULUS on this field in due course,

6. the format of the data should be acceptable by FAMULUS: this involved the appearance of the four-character field label with each field-entry, a space between fields and a double space between records.

The program called PHYSDIR (see Appendix A.4, Program 1) achieved these ends.

Line 60+ created a data-file under the title of the programmer's choosing.

Line 160 set up a 2 by 16 array to keep two records in RAM at any one time. This allowed the ready duplication of data from a previous record into current fields.

Line 220 when the field SYLL was read from the data list
 (lines 460-490) the heading corresponding to
 the number entered for INDX in line 230 was
 read by PROCSYLL (lines 920-1050).

Line 280 the field label, a space and the data entered
 as A\$ were stored in the array.

Line 240 gave the option of entering * for the data. If
 this was confirmed after a warning tone, then
 the contents of all subsequent fields were
 duplicated from the previous record by
 PROCREPEAT (1110-1170).

Line 350 gave the option of correcting some of the
 entries (PROCCORRECT 770-860) or of saving the
 record to disc (PROCDISCFIL 560-610).

Line 370 ensured that if the record was saved to disc,
 it was also copied into the first array space,
 thereby updating the duplicating facility.

It will be seen that the data was recorded on disc as a
 sequence of strings, each containing the field-label and
 data.

Having achieved a file of data on BBC disc, it was then
 necessary to transfer it into a data-file on the Burroughs
 B6700 machine. This was achieved by the transfer program
 "HPUTD" (see Appendix A.4, Program 3), mentioned above,
 written by JPR Palfrey of the Computer Unit, University of
 Warwick who specialised in micro and mini-computer work.
 However, the format and structure of a BBC string file when
 saved to disc is unusual. The ASCII codes for characters
 are stored on the disc with those at the end of the string
 coming first, so it was necessary to write a conversion

program which reversed the order of the ASCII codes, and placed them in a newly created file for the Burroughs. The FAMULUS package required return codes to be inserted between fields and a double return between records. This was achieved with the program "BBC>BUR" (see Appendix A.4, Program 2).

The transfer of data was achieved by taking a BBC-B machine with disc-drive to the Computer Unit and linking to the Burroughs by line. Transfer was not very fast, but about one third of the Directory could be transferred in about three quarters of an hour. A program which operated in the reverse direction to "HPUTD" called "HGETD" enabled data files to be transferred from the FAMULUS package to BBC disc, and this was later used to obtain hard copies of the Directory.

A recent development, which allows the transcription of discs in BBC format to a format compatible with the 'Super-brain' minicomputer, will greatly increase the ease and speed of this kind of transferring operation, and it is hoped that the BBC soft-ware generated in this research for allowing ready preparation of ASCII data files suitable for FAMULUS away from the Unit will help other users.

Checking Directory entries and contacts within industrial institutions

Having created the data-base using the FAMULUS package, the records were sorted first on the TITL field, to put them in alphabetical order, then on INDX to put them in syllabus order. The GALLEY program within FAMULUS ensured that the syllabus headings were only printed once and that the records were separated by suitable spaces. This revealed any duplication of entries or errors in syllabus headings.

Since it had taken over eighteen months for all the material to be assembled, it was essential that the entries should be sent to the publishing sources so that the availability of the material and the accuracy of the entry might be checked. It was also important that an up-to-date contact be established in each institution to facilitate future requests for materials or checking of entries.

The covering letter and the two forms (see Appendices A.5 and A.6) were sent out to the publishers in June, 1984, together with a printout of the entries for the materials they produced. This was achieved by sorting the records on PUBL and DIST. They were encouraged to send details of any new materials which might be relevant on the pre-coded forms, and to make all returns by 20th July if possible.

Of the 52 organizations contacted, 42 had replied by the agreed date, or shortly afterwards, and of the other 10, eight were approached by telephone and then either returned the forms, or confirmed details over the telephone. Only two institutions failed to respond positively, and as they each only produced very few materials, they were deleted from the Directory.

Some twenty items had been withdrawn, or were then out of print, and the details of some of the rest, particularly cost, had changed since the catalogues or materials had been received. These were corrected directly in the FAMULUS data-base.

It was notable that in most cases where corrections to entries were not received promptly, the problem had been one of sending the details to the wrong section or division within a company. Often the original enquiry had been referred to another department, but there was sometimes little consistency in this. Telephone enquiries to these

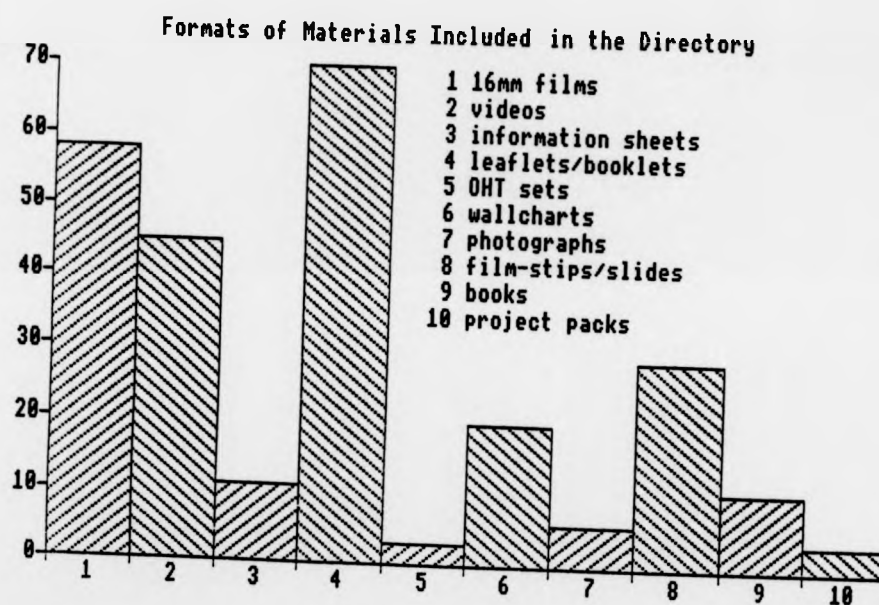


Figure 5.1

same companies often met the same fate, and it was clear that employees frequently had little awareness of the groups which were producing educational materials within their company.

Despite a second appeal to donate material to the library of resources being established at Warwick University, Westwood Library, there were comparatively few positive responses, although the request was for specific materials and it was clear by this stage that these materials were to receive wide publicity in the Directory. It seemed that the company policy on whether materials should be charged for or not was decided on general principles, and that the staff dealing with the requests were unable to go outside these general guide-lines, even when asked to donate materials to what the author, at least, regarded as a worthy cause!

Publication of the Directory and the response

By October, 1984 the final version of the Directory was ready for dispatch to the Publications Committee of the Association for Science Education.

In all some 224 items were listed, published by 46 organizations. This represented somewhat less than 10% of the total of items reviewed: those which were relevant for the the teaching of physics in school.

Figure 5.1 shows the distribution of the various formats of materials included in the Directory. It will be seen that 16mm films and leaflets or booklets predominate, with videos, film-strips or slides and wallcharts occurring less frequently.

It was hoped that advance publicity could be given to the

Directory in the November mailing of Education in Science and a print-run of 500 put through in December. Eventually, both these operations were put back by a month, and the A5 leaflet advertising the Directory was sent out in the mailing for January, 1985 and the Directory was published in February at a price of £1.25. A copy of the completed Directory is included as Appendix A.7. By this time 200 orders had already been received by the ASE. By June of 1985 all of the original print-run of 500 had been sold and a second printing was undertaken.

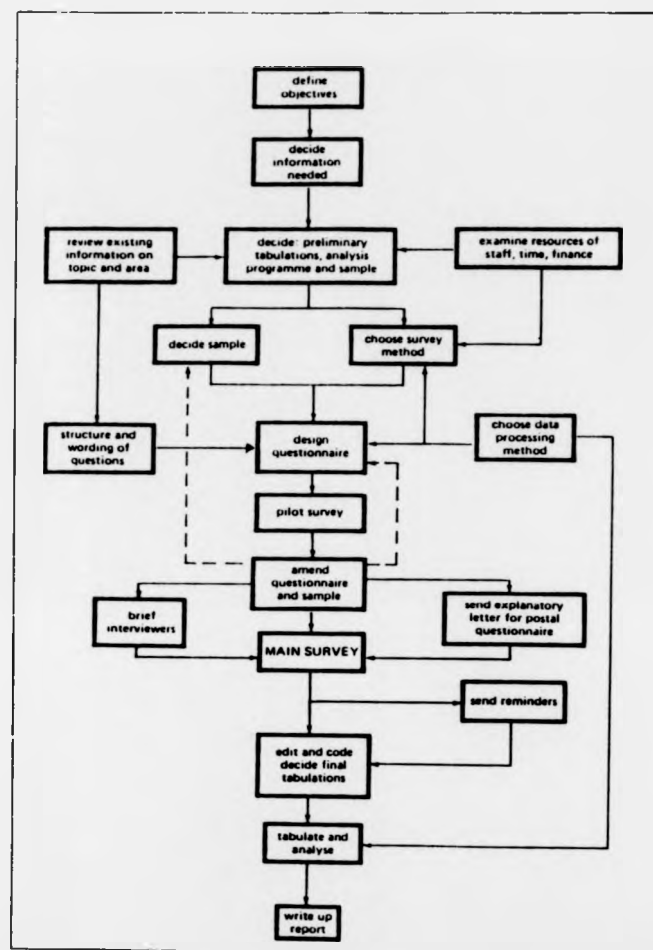


Figure 6.1

CHAPTER 6

COLLECTING AND ANALYSING TEACHERS' RESPONSES
TO THE DIRECTORY AND TO THE MATERIALS

DESIGNING THE SURVEY

The strategy for designing the survey is summarised admirably by the flow-chart shown in Figure 6.1. Stages in the planning of a survey (COHEN & MANION 1985, Box 4.1, p.95) derived from DAVIDSON 1970, though brief interviews were not appropriate prior to the main survey, and the telephone was used for "reminders".

The objectives of the survey were clear; to obtain a perspective of the background of teachers who responded to the questionnaire, gauge their reactions to the Directory and the materials, and to try to discover the audio-visual aids which were available and which were used regularly.

The information required was decided upon in two stages: firstly by trying to anticipate the factors which would influence teachers' use of materials and secondly, monitoring the free responses to the pilot questionnaire.

There was little systematic information available in the area of the study, so one was working very much ab initio. The time and financial constraints within which the research was to be conducted dictated that even the main questionnaire sample would be of limited statistical significance, possibly paving the way for a more comprehensive survey with the publication of a second edition of the Directory. Materials, and more so their evaluation, is an ephemeral exercise, and tentative results were required quickly to inform future practice.

DESIGNING THE QUESTIONNAIRE STUDY

The Pilot Study

The original intention when the study was devised in 1982, was to circulate teachers with a questionnaire to establish their pattern of usage of "industrial" materials and to gain some information about the educational establishment where they taught, their experience and teaching commitment and to follow it up with another, after they had been given the opportunity to examine the Directory's contents and to order materials, to monitor its effect, but circumstances dictated that the two stages be combined, for reasons of the short time-scale to complete the survey and cost. The practicality of ensuring a sufficient sample of double replies also put the double-sampling method in doubt.

As a prototype for the first of these, the questionnaire form included in Appendix A.1 was devised. As can be seen, the responses were partly coded, but scope was also given for free response, as, at this stage, one was making educated guesses for the range of answers teachers might wish to give, and the information obtained would help to provide the options for a coded questionnaire later. Also, since material was still being solicited from organizations, Question 7 asked teachers to recommend material which they had found particularly successful, to try to extend the net to as wide a range of sources of material as possible. These are strategies of universal application in questionnaire construction (see YOUNGMAN 1978, p.6).

In order to get quick and assured feed-back from a wide range of teachers (other scientists as well as physicists), it was decided to take part in the poster exhibition at the

annual meeting of the Association for Science Education at Manchester in January, 1983. For three hours one afternoon, a two metre section of display board carried information about the background, scope and intentions of the Resources Directory, and teachers were invited to complete a questionnaire and to leave their names and addresses for future circulation about the Directory. Interest was high; many stopped to read the information or to ask specific questions about the project. Some 57 teachers left their details for future circulation and 25 teachers completed the pilot questionnaire.

There was considerable support expressed for the project, both because teachers were aware that they wanted to include more material of relevance to industrial applications in their teaching, and because they had found it a daunting process to obtain material from the very wide variety of organisations and companies which produced and issued such material.

Although the sample could not be regarded as in any sense "representative", analysis of the replies threw useful light on the design of the definitive questionnaire.

The 'type of school' question, suggested that the four categories of Comprehensive, Sixth-Form College, Technical College and Independent would cover the substantial majority of options, and these were included as the four coded answers in the eventual questionnaire (see Appendix B.1). In the event they accounted for some 92% of the responses.

The responses to the question 'If you teach any subject other than physics, please indicate which:' suggested the inclusion of Mathematics, Computing and CDT together with the other sciences.

Question 1 resulted in the categories 'From Science Adviser', 'By writing to companies' and 'At ASE annual meeting' being added to the responses to Question 13 of the final questionnaire.

Question 2 prompted the inclusion of 'TV', 'Radio' and 'Audio-cassette player' as responses to Question 21.

Discussion with teachers suggested the need for more information about the educational establishments in which they taught, thus Questions 2 to 5, and Question 12 in the second questionnaire.

A list of some 48 companies which had already been approached for materials was shown to teachers, and they were asked to recommend any sources which had been missed. Only four of the 25 teachers who completed the questionnaire made suggestions, some of which were most helpful, though they were generally of large, national or multi-national companies. In the final version of the Directory materials produced by some 46 sources were included, only 30 being common to the list used at the ASE meeting. This was because many of the materials which were eventually sent by the original sources proved unsuitable.

The final question, number 8, elicited the suggestions of Times Educational Supplement and Education Guardian, and these, together with the IoP's Snippets were added in the final questionnaire under Question 14.

The pilot study had been most useful, as it allowed a more certain coding of the responses in the final design of the questionnaire, essential if the analysis was to be computerised. It suggested changes of detail in the wording of questions, where these were ambiguous, and sub-dividing

the responses, particularly in the use of visual aids. It also emphasised the importance of asking teachers to list choices in order of preference when identifying several alternatives from a list, otherwise the analysis of the significant responses would be made difficult by the masking effect of the large number of choices.

The sample population

Probability samples would have been too large and inaccessible to canvass within the necessary projected scope of the survey, and too expensive, given that all had to have a copy of the Directory. It was decided to settle for a combination of 'convenience' and 'dimensional' sampling. (See COHEN & MANION 1985, p.100.) As well as a sample of committed teachers, it was considered desirable to include two groups who had not taken the initiative to acquire the Directory. This was for two reasons: firstly, those who ordered the Directory may have a predisposition to be interested in and informed about "industrial" materials, so the background information about their previous use of materials and pattern of ordering might not be typical, and therefore of less help to producers of such materials; and secondly, using groups selected on a criterion other than having ordered the Directory, might suggest useful strategies for those hoping to promote materials in the future, or to inform teachers of where to gain relevant information.

To enable one to survey these other groups, it was of course necessary to provide them with complimentary copies of the Directory, and in March, 1983 the Institute of Physics was approached under its "Small Grants" scheme to teachers to provide the funds to cover the copies of the Directory and the administrative costs. Such funds were

readily forthcoming, and the two groups chosen were:

a) all the secondary schools in one education authority area (Leicestershire), and

b) a group of teachers who had written for information about the 'Process Curriculum' initiative at Warwick University.

Sample (a) provided intensive coverage in one geographical area, so hopefully would target a wide range of teacher commitment to 'industrial' materials.

It was hoped that sample (b) would consist of teachers selected nationally, having no assumed commitment to the use of "industrial materials" or special knowledge of them.

Rather than include questionnaires with copies of the Directory, the Association for Science Education made available the names and addresses of those ordering the Directory in the months of January to May, 1985 for subsequent circulation, and these composed the third sample. Sizes of samples and response rates are given in the next section but one, under the results of the questionnaire study.

Design of the questionnaire

Three main sources on this technical matter were consulted: YOUNGMAN 1985, BURROUGHS 1971 and COHEN & MANION 1985. A copy of the questionnaire is included as Appendix B.1.

To facilitate analysis by computer, the questionnaire was arranged with single-column codings for the responses to the questions and was limited to 80 columns, this being the standard "form size" for many of the statistical packages

available on the main-frame computer; in particular SPSS (The Statistical Package for the Social Sciences) and BMDP.

The length was restricted to four sides of A4 and the layout kept as clear as possible to encourage teachers to start, and to complete (!) the questionnaire. They were asked to use a red or green pen to ease the job of transcription by the Computer Unit staff.

Personal details were requested at the top of the first page to act as a cross-check on the sample group and to avoid duplication if teachers were sent questionnaires because they were members of two of the sub-set samples. It was stressed that this information would be regarded as confidential and would not be disclosed outside the department.

Background The first section attempted to gain information about the school, the experience and teaching pattern of the teacher and the ways in which information about "industrial" materials was usually and most frequently obtained.

The Directory The previous use and knowledge of materials, and the influence of the Directory in prompting teachers to order new materials was examined in this section, together with feed-back about the arrangement of the items within the Directory.

Use of Materials The final section dealt with the resources available to a teacher on a regular basis, the formats of materials already used in teaching and the greatest time for which materials were used.

THE ANALYSIS OF THE QUESTIONNAIRE DATA

Recording the data

As mentioned above, the original intention was to use one of the main-frame packages to analyse the data. Although some of the data had already been placed on the computer by the processing staff at the Computer Unit, this attempt was quickly abandoned. This was firstly, because the packages proved quite difficult to "drive"; the format for the data was rigidly prescribed, and although some trouble had been taken to ensure that it could be entered as easily as possible, it proved tiring to do at a terminal, and the computer unit staff were not always available. Secondly, the error reporting system on the Burroughs B6700 computer then in use at Warwick University meant that it was very difficult to establish what the problem was when a procedure failed to operate successfully. Thirdly, and most importantly, the SPSS package did not deal happily with non-parametric statistics of discrete variables, which were the predominant type in the survey. As much experience had been gained from developing the programs to match the BBC micro to the Burroughs in entering the data for the Directory, it was decided to devise the necessary software for analysis of the questionnaire for the BBC micro-computer. This gave the considerable advantage of being able to work at home, entering the data as the questionnaires came in. The disadvantage was the considerable amount of developmental work and the comparatively limited memory and operational speed of the BBC machine. It was hoped that the programs devised might be useful to others undertaking small-scale surveys.

The computer programs for entering the questionnaire data

The programs written for and used in analysing the data provided by the survey questionnaires are listed in Appendix B.2, together with "REM" statements to highlight their structure.

'RECDATA' (Appendix B.2, Program 1) was designed to allow entry of the data to disc, record (questionnaire) by record. There were internal checks to ensure that the correct column-structure was adhered to, together with comprehensive checking and correcting Procedures. To make entry as easy as possible, the data referring to the questions on one page of the questionnaire were printed in separate columns on screen. The data for each record was then recorded as a single string within the file 'physdir'. Since some of the questions had double-column responses, some of the data required two ASCII codes. Blanks were left between blocks of columns to ease reading the printout of the record data, a complete listing of which is given in Appendix B.3, Table 1.

The program 'FILECOL' (Appendix B.2, Program 2) takes a single ASCII code character from a fixed position in each record-string in turn, and combines them into a new string, representing the responses for a given column in all the original questionnaires, and records them in file 'C'. This procedure would limit the number of questionnaires which could be processed by this method, since the maximum permissible length of a string is 255 characters (2^8 to the eighth power minus one).

'COL/STR' (Appendix B.2, Program 3) takes the column file 'C', puts double column data in pairs in a single, double-length string and excises null strings, recording the results in the file 'columns'. A complete print-out of

the full 'columns' file is given in Appendix B.3. Table 2. This effectively limits the total number of records (questionnaires) to half the maximum permissible length for a string i.e. $255/2 \Rightarrow 127$. Since there were 99 questionnaires returned during the period anticipated, there was a suitable margin for any late returns.

It was important that the two files 'physdir' and 'columns' could be read easily and printed out in a clear format to enable manual checking for errors and consistency. The two programs 'READphy' and 'READcol' (Appendix B.2. Programs 4 and 5) provided this function for the files 'physdir' and 'columns' respectively. A convention of upper-case for programs and lower-case for files was adopted.

The computer programs for analysing the data

The program 'STATTOT' calculates the total statistics on the columns of the file 'columns' (see Appendix B.2. Program 6). It provides a straight count of the responses to a given question. The print-out is given in Appendix B.3. Table 3. Much of the fundamental information about the survey was obtained from this analysis.

It became clear that one of the important features of the statistical packages should be to allow analysis of particular columns, given certain responses in another; for instance, an examination of the use of existing "industrial" materials (C41) categorised by a teacher's experience of teaching physics (C11). 'STATSEL' provides this selective statistics facility, (Appendix B.2. Program 7). In order to save print-out paper and to ease formatting, an alternative program 'SPLSTAT' (Appendix B.2. Program 8) was written to spool the results of 'STATSEL' as the file 'cmpstat', though the results of different sessions were renamed 'stats1', 'stats2' etc., to ease

identification.

Some questions (Q11, Q13, Q14, Q20 and Q21) allowed three or more choices to be given in response, and it was useful to be able to take the total response for such a question in any selective comparison. The program 'STATSET' achieved this, though it became a slow process to generate a full set of results for a question with five choices and 16 or 22 possible responses! A possible improvement would be the storing of data in arrays so that the whole of one string could be examined at once, but since this would require the substantial restructuring of the program, it was decided not to attempt a modification for the small extra use to be made of it.

To evaluate the significance of various distributions, a non-parametric test of high flexibility was required. The literature indicated that the chi-squared null-hypothesis test was the most generally suitable technique, its only requirement being that no expected frequency class should contain fewer than 5. Two tests were used: the first gave a measure of the probability that a sample had been drawn from the parent population by chance. The second, compared two samples listed in a contingency table, and indicated the probability that they were drawn from the same parent population by chance. A low probability indicated that there might have been a significant difference between the two samples. (See MORONEY 1953, p.250 for a general discussion of chi-squared techniques and p.254 for an introduction to Yates' correction for a 2 by 2 contingency table involving low frequencies.)

THE RESULTS OF THE QUESTIONNAIRE STUDY

N.B. In the discussion which follows, question numbers (Q1, Q2, etc.) and column numbers (C1, C2, etc.) refer, respectively, to the questions and answer columns of the Directory Questionnaire, a copy of which is included in Appendix B.3.

THE SAMPLE

Questionnaires were sent to three sample groups of teachers, selected as described above. The numbers of questionnaires returned by each group expressed as a percentage response were as follows:

Sample Group	Sent	Returned	Response
1 Leicestershire schools	c.60	9	15%
2 Warwick 'Process Curriculum'	125	42	34%
3 ASE Directory orders	148	48	32%

The response from Group 1 was disappointing, but the questionnaires were distributed centrally from the County Authority and the number of schools circulated was probably nearer 48. This, compounded by an early end to the Summer term so that many teachers did not receive the Directory and questionnaire until after the suggested return date, probably accounted for the low percentage response. Also, the Directories were not addressed to individual teachers by name, as were the copies sent to the other two sample groups.

The response from Groups 2 and 3 was slightly below the expected 40% standard first dispatch level for

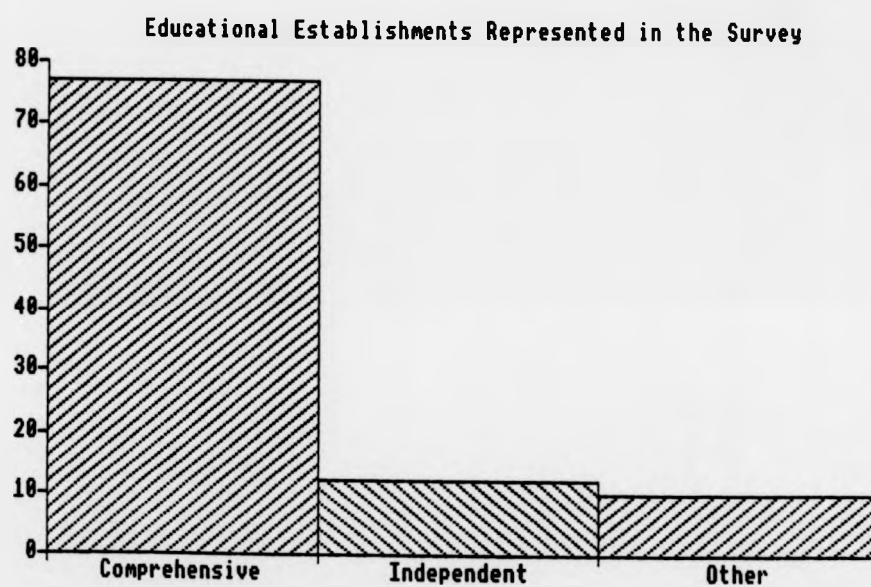


Figure 6.2

questionnaire research (COHEN & MANION 1985, p.111). It did not seem appropriate to circulate those who had not replied a second time, which might have been expected to increase the response by some 20%, because a 50% response rate would not have produced a significant sample for the whole population of teachers and the further delay and expense were undesirable.

It might be objected that the small sample of teachers included in the survey and the schools represented in it were atypical when compared with the national position. The next two sections examine this. However, it should be noted that the third sample group of teachers expressed an interest in IPRM by ordering the Directory, and so a low incidence of use and awareness of IPRM among this group and over the sample as a whole, would give greater weight to the present thesis than a "typical" sample.

THE SCHOOLS REPRESENTED IN THE SURVEY

Q1 Type of educational establishment

77% of the teachers who responded to the survey taught in Comprehensive schools, 12% in Independent schools, with none of the other categories accounting for more than 3% of the sample. (See Figure 6.2.) 91% of teachers from the maintained sector taught in Comprehensive schools.

Compared with national figures, taken from The 1984 Secondary School Staffing Survey (STATISTICAL BULLETIN 1986, Table 9) which show that 211 000 teachers (89%) from the total of 238 300 in the whole of the maintained sector teach in Comprehensive secondary schools (including Middle (Secondary)), the survey sample included a typical proportion of such teachers (91%). Although figures for

independent secondary schools were not available separately, one suspects that 12% represents a rather higher percentage than would be expected from the proportion of secondary schools which are independent.

An analysis of school types represented in the survey, revealed an interesting departure from expected statistics. In the survey, 77 of the 84 maintained secondary schools were Comprehensive compared with 3340 of the 4553 maintained schools in the 1984 Statistics in Education: Teachers in Service (TEACHERS IN SERVICE 1984, Table B128, p.23); 92% and 73% respectively. This indicates that other maintained schools, Sixth form College, Grammar and Voluntary Aided, are under-represented.

An analysis of school-type represented by sample group revealed the expected preponderance of Comprehensive schools; 67% of the Leicestershire group, 90% of the Warwick Process group, and 69% of the ASE group.

Q2 and Q3 average age of youngest and oldest pupils

Since 78% of the survey were Comprehensive schools, it seemed appropriate to compare the age-ranges of schools in the survey with those of Comprehensive, maintained secondary schools in the general population.

The figures for the general population are taken from the 1984 Staffing Survey (STATISTICAL BULLETIN 1986, Table 9).

	11-13/4	11-16	11-18	13/4-18
Nationally	16 200	57 100	117 400	20 300
Survey	11	29	32	10

The 11-18 schools seem to be under-represented in the survey.

Q4 Size of educational establishment

The statistics are summarised in Figure 6.3. Establishments had rolls greater than 500. 42 had rolls greater than 1000. Only one establishment fewer than 200 pupils. 47% of Comprehensive schools have rolls between 500-1000 compared with 59% of other schools together. 48% of Comprehensive schools were >1000 compared with only 18% of other schools together, so that about half of the Comprehensive schools were 'large' schools (>1000).

There was no significant difference in the size of schools in the three sample groups.

If the numbers of the schools in the survey are compared in size with the national figures, extrapolated from the statistics as at January 1983 (TEACHERS IN SCHOOLS Table A3/B3), it is found that the Comprehensive schools in the survey were typical of Comprehensive schools in the population as a whole.

Comprehensive Schools	<500	500-700	700-1000
Nationally	326	543	116
Survey	2	10	26

When the sizes of all maintained secondary schools in the survey are compared with the total maintained secondary school population, the picture is very different.

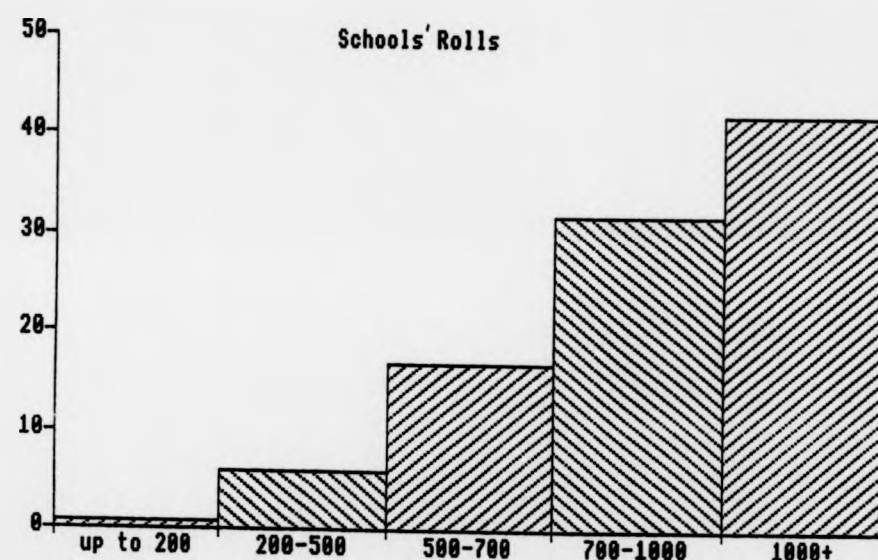


Figure 6.3

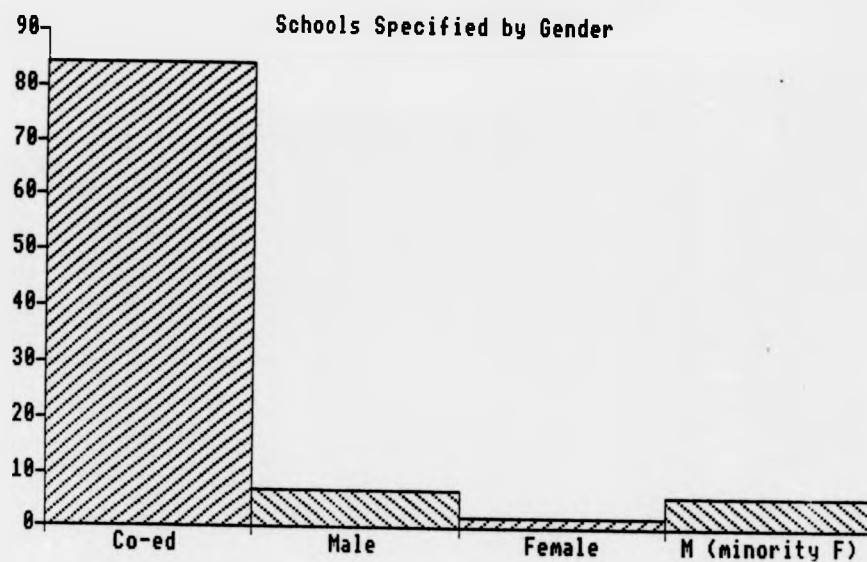


Figure 6.4

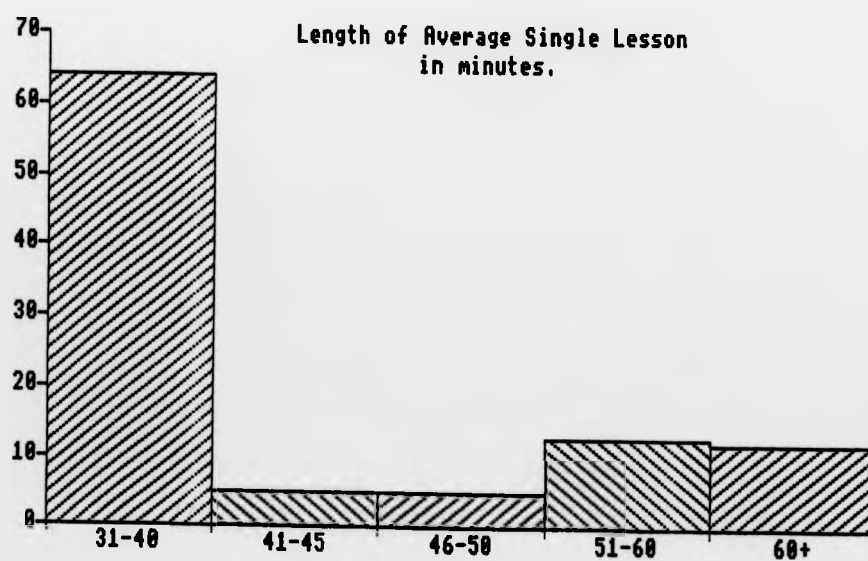


Figure 6.5

All Secondary	<500	500-700	700-1000	1000+
Nationally	991	864	1346	1355
Survey	3	13	28	40

The survey is strictly of teachers not schools, so one would perhaps expect larger schools with more staff to be more strongly represented than small schools with fewer staff.

Q5 Gender groups of schools

See Figure 6.4 for a summary of the distribution. As might be expected, 84 of the 99 schools in the sample were co-educational, other patterns being too few to be representative.

Q12 Length of a single lesson

Figure 6.5 shows the distribution of lesson length in minutes for the schools in the survey. A considerable majority (64) had lessons which lasted between 31 and 40 minutes, though about a third of this number (25) had single lessons lasting longer than 51 minutes. It is not possible to discern from the questionnaire the occurrence of double lessons, which would of course increase the teaching time available for the use of materials for some schools.

A comparison of C1 and C80 with C27 revealed no departure from this trend, either for different types of school or for different survey sample groups.

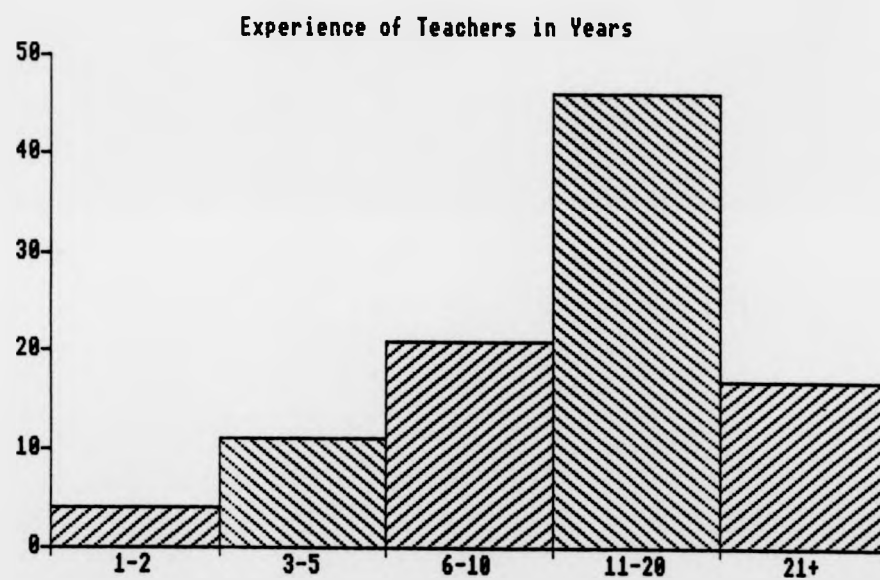


Figure 6.6

THE TEACHERS REPRESENTED IN THE SURVEY

Q6 Physics teaching experience of teachers

It can be seen from Figure 6.6 that the number of recent teachers (less than two years' experience) represented in the sample is small, 63 having more than 11 and 17 more than 21 years' experience of teaching physics.

On the assumption that the majority of teachers enter the profession immediately after initial training at an average age of 23 and remain in teaching, the statistics of ages for the teaching profession as a whole may be converted to years' teaching experience. Using the data from the DES as on 31st March, 1984, (TEACHERS IN SERVICE 1984, Table B128) the figures are as follows:

Years' Experience	<6	6-21	>21
Nationally	54 089	124 154	63 281
Survey	15	67	17

The survey contains rather more teachers at the beginning of their training than the national figures, and rather fewer senior teachers.

There was remarkably little difference in the experience profiles of the three sample groups, the only point of note being the absence of any teachers with less than six years' experience from the Leicestershire group, which may be accounted for by the fact that the Directory was dispatched to Heads of Department.

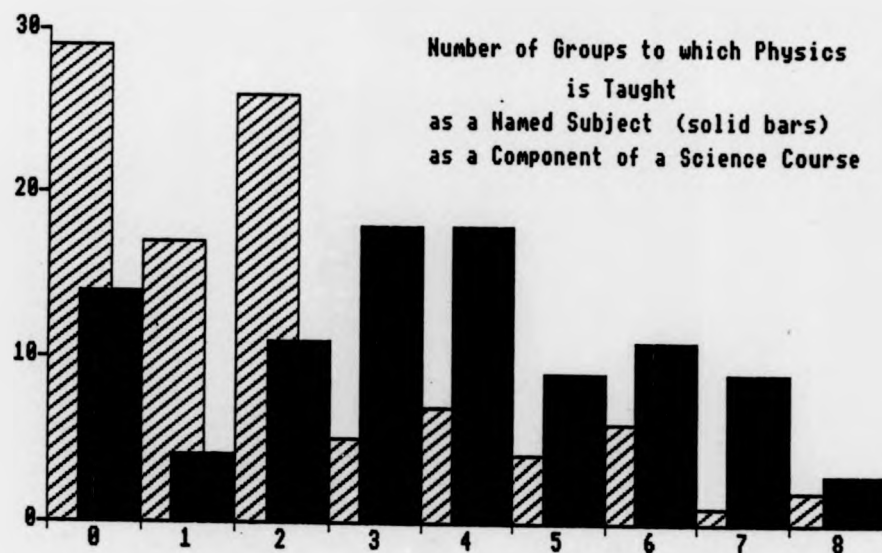


Figure 6.7

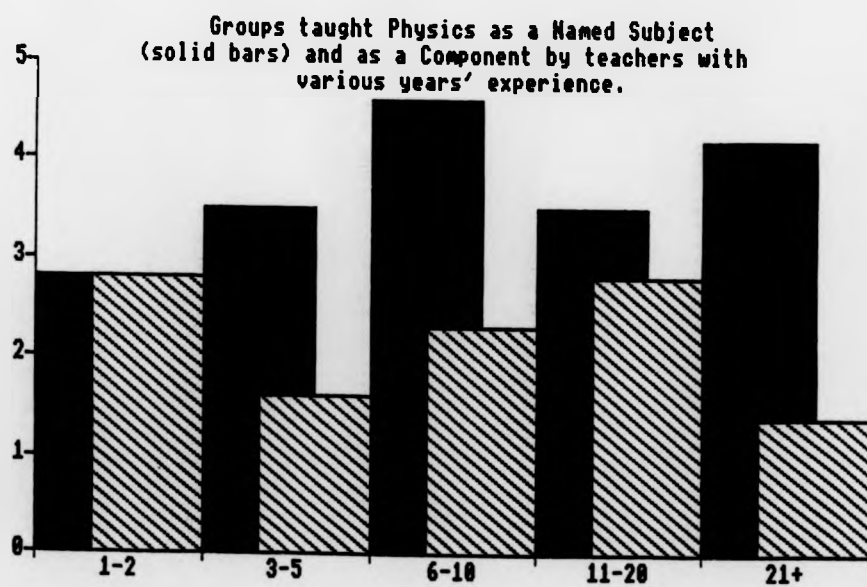


Figure 6.8

Q7 and Q8 Physics teaching commitment of teachers up to 16+

The comparison between the teaching commitment to groups taught physics as a named subject and as a component of a science course can be seen in Figure 6.7. Only 14 teachers did not teach physics as a named subject, 33 taught fewer than 4 groups and 71 fewer than 7 groups. One teacher claimed to teach 16 groups physics, but since he worked in an Independent school, age-range 11-12/13-15 it is probable that the term 'group' was misinterpreted. 29 did not teach physics as a component, 48 taught fewer than 4 and 65 fewer than 7 groups. Two taught 18 and 22 groups respectively, both teaching in medium sized, 11-16 Comprehensive schools, possibly in a team-teaching environment?

By taking the mean of the frequency intervals for years' experience of teaching physics (C11), it was possible to calculate the average number of groups taught physics as a named subject and as a component by these teachers. The results are shown in Figure 6.8. Apart from those teachers with less than two years' experience of teaching physics as a named subject (av 2.8 groups), there is little evidence that experience influences the number of groups taught. It is interesting that the sample of teachers responding to the questionnaire is likely to be teaching twice as many groups physics as a named subject after their first two years. This may have been a direct result of the specific reference to physics in the title of the Directory for those who ordered from the ASE, and of course the Leicestershire teachers were Heads of Physics, and Heads of Science and Heads of Physics were preselected from the Warwick 'Process Curriculum' group.

There was no appreciable difference between the sub-groups of the survey as regards C13 or C16.

Q9 Physics examinations at 16+

69 teachers in the survey (70%) enter pupils for an examination including physics at 16+. Given the shortage of physics teachers and that pupils usually elect to continue physics for an examination, this relatively high figure is, perhaps, not surprising.

By comparing C19/C13 and C19/C16 it seems that those teachers entering pupils for an examination were likely to teach marginally more groups physics as a named subject (av 4.1) than those who did not enter examination candidates (av 3.2). There was no significant difference in the numbers of groups taught physics as a component by teachers who taught examination groups or those who did not.

If teachers taught physics at 'A'-level, they were slightly more likely to teach groups physics as a named subject below 16+ than if they did not teach at 'A'-level (av 4.1 cf 3.2), while they were slightly less likely to teach physics as a component (av 2.3 cf av 2.5).

Q10 'A'-level physics teaching

65 teachers (66% of the sample) teach physics at 'A'-level.

A comparison of C21 with C13 and C16 indicates that teachers of 'A'-level physics do not teach physics as a named subject to many more groups below 16+ than those who do not teach at 'A'-level (av 4.0 cf 3.4). Interestingly, although the average number of groups taught physics as a component by teachers of 'A'-level physics is only half the average number taught by non-'A'-level teachers, the average is heavily weighted at the upper end, and of course teachers not teaching groups in this category do not count

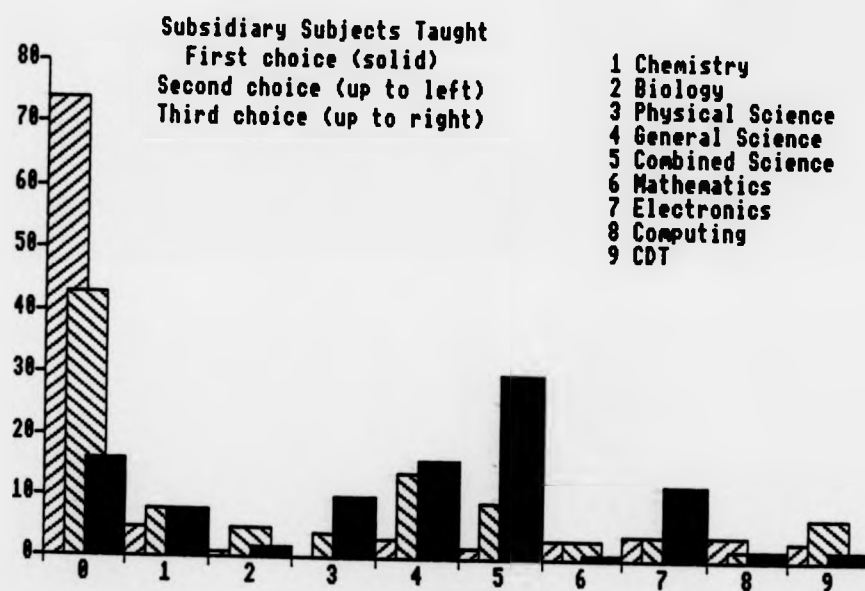


Figure 6.9

towards it.

If one teaches at 'A'-level, one is likely to be teaching fewer than two groups physics as a component, which is consistent with the distribution for C13.

To gain some indication of the "internal consistency" of the responses to the questionnaire, a comparison was made between C21 and C5. As was to be expected, the average age of the oldest pupils in the majority of the schools who employed teachers of 'A'-level physics was 18+, but 17 teachers (26%) of this group reported teaching physics at 'A'-level when the average age of their oldest pupils was 16-17, so they would seem to have examination candidates at 17, or perhaps only to teach the first year of the course to school-leavers.

Q11 Subsidiary subjects taught by physics teachers

Just 16 teachers in the survey taught only physics, 57 taught at least two subsidiary subjects and 26 taught at least three.

Figure 6.9 shows the principal subsidiary subjects taught by the sample. 56 taught some form of Combined or General Science (categories 3, 4 and 5) as their most important subsidiary subject, 12 Electronics, 8 Chemistry, 2 Computing and 2 CDT. Overall, 23 taught some Chemistry, 20 Electronics, 12 CDT and 8 each taught some Biology, Mathematics and Computing.

A comparison of C11 and C23, in an attempt to examine whether experience as a physics teacher influenced the principal subsidiary subject taught, revealed little difference between those of differing experience. Those

with 11-20 years' experience seemed to make the most varied contribution in their principal subsidiary subject, though 35% taught no subsidiary subject compared with 16% of the whole sample, perhaps because posts of responsibility dictated that they teach their specialism exclusively? It might, in retrospect, have been useful to include physics in the list, to identify those teachers for whom it was not the principal teaching subject. One might guess, however, that the survey produced replies from a substantial majority of teachers whose principal subject is physics.

When experience is compared with total commitment to subsidiary subjects, the non-named 'sciences' led markedly, nearly 42% of teachers in their first two years teaching some science, the percentage falling until only 22% of those of 21 years' standing or more taught some 'science'. There is a particularly sharp drop for those in the 3-5 year category (15%), accompanied by a significantly high percentage engaged in teaching some Electronics and CDT.

If not teaching at 'A'-level, only 3% of teachers taught no subsidiary subject compared with 23% of those who taught at 'A'-level. Some science (categories 3 to 5) was taught as the principal subsidiary subject by 47% of those teaching at 'A'-level compared with 73% of those not teaching at 'A'-level, while Mathematics was taught as the principal subject by 18% of those teaching at 'A'-level and by no-one not teaching at 'A'-level.

When compared with overall commitment to subsidiary teaching, 27% of those teaching at 'A'-level made some contribution to 'science' teaching to 16+, while 37% of non-'A'-level teachers made the same commitment. Chemistry was taught by more of the non-'A'-level teachers (13% cf 4%), while Electronics was taught by more of the 'A'-level teachers (9% compared with 3%). Perhaps this was because

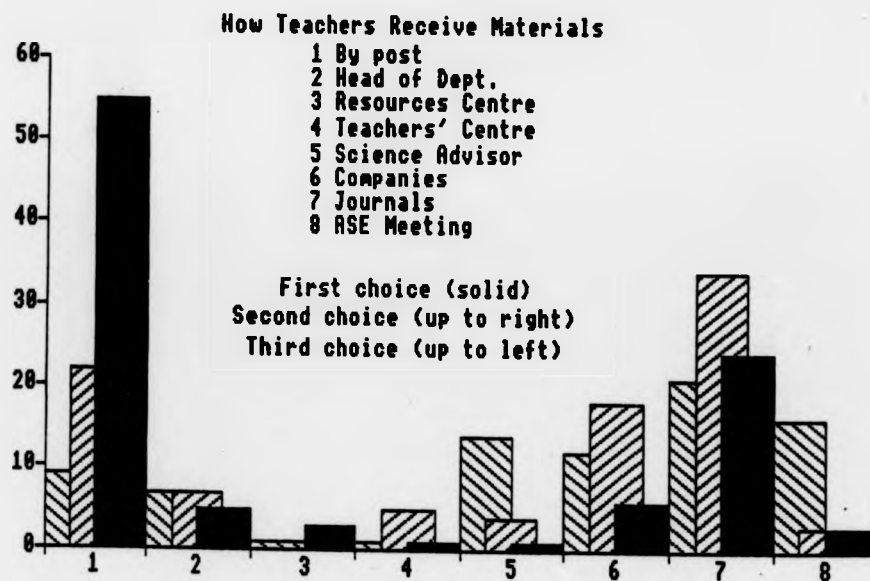


Figure 6.10

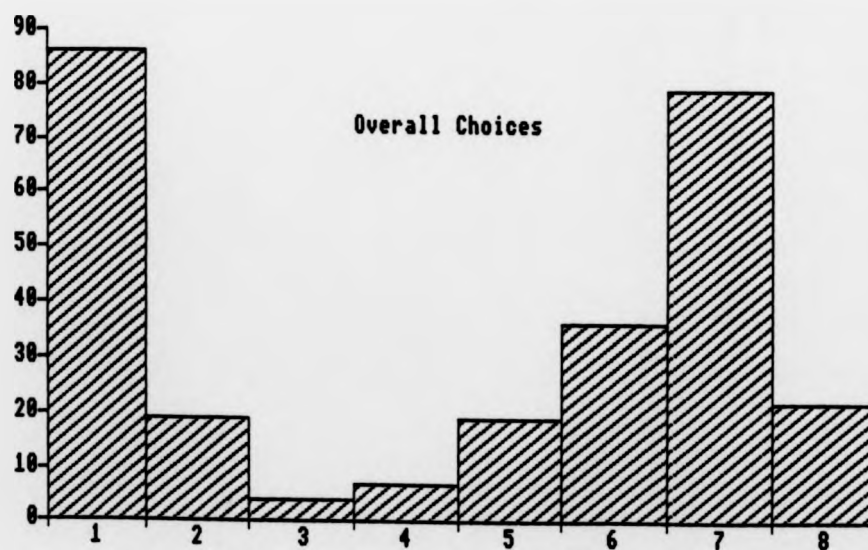


Figure 6.11

Electronics tends to be viewed as a technical subject, the province of the specialist Physicist, while Chemistry is a component of all 'science' courses and so is more likely to be taught by the same teacher. The overall contribution to Chemistry above would confirm this, though the Biology contribution is substantially lower, perhaps indicating that Chemistry is taught by teachers who are principally Physicists or Biologists.

The rise in commitment to Electronics, CDT and, to a smaller degree, Computing in the middle years, is consistent with the delegation of these responsibilities to those who are neither new to the profession, nor yet responsible administratively for their main teaching subject, physics. It is also possible that their training, and their own school experience, equipped them better for these 'innovatory' subjects than their senior colleagues.

Q13 Methods of receiving information about materials

Figures 6.10 and 6.11 show the relative importance of methods for receiving information about industrial materials under first, second and third choice (C29,30 and 31) and overall. The pre-eminent principal method was clearly 'by post to your school' (55), the next most frequent method was 'by reading journals' (24). These two methods also featured strongly in the overall analysis of responses, with 'by writing to companies' occurring almost half as frequently (36 cf 86 and 79 respectively).

Five teachers received information by only one method and eleven by only two. Clearly, school mailing is an effective method, provided it is targeted, and advertising in journals can be effective (the most widely read are identified in the next section).

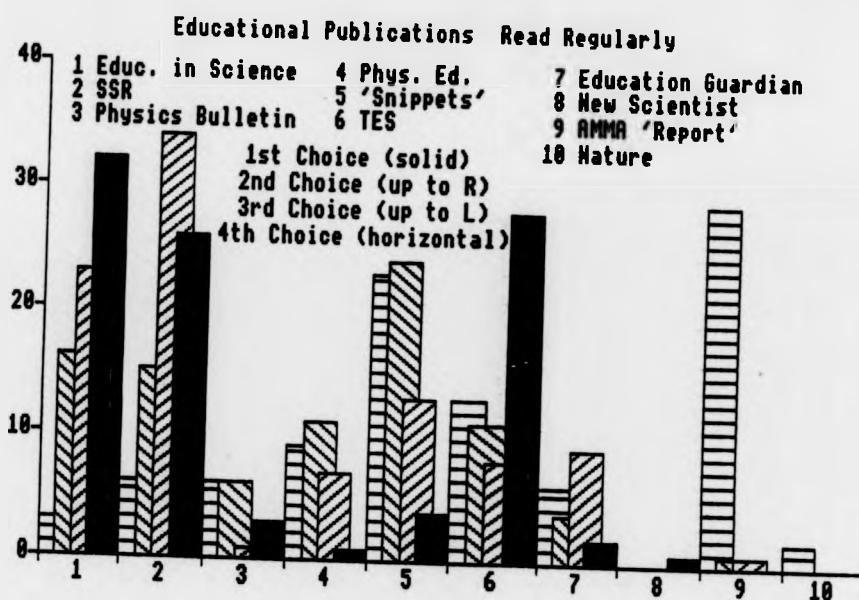


Figure 6.12

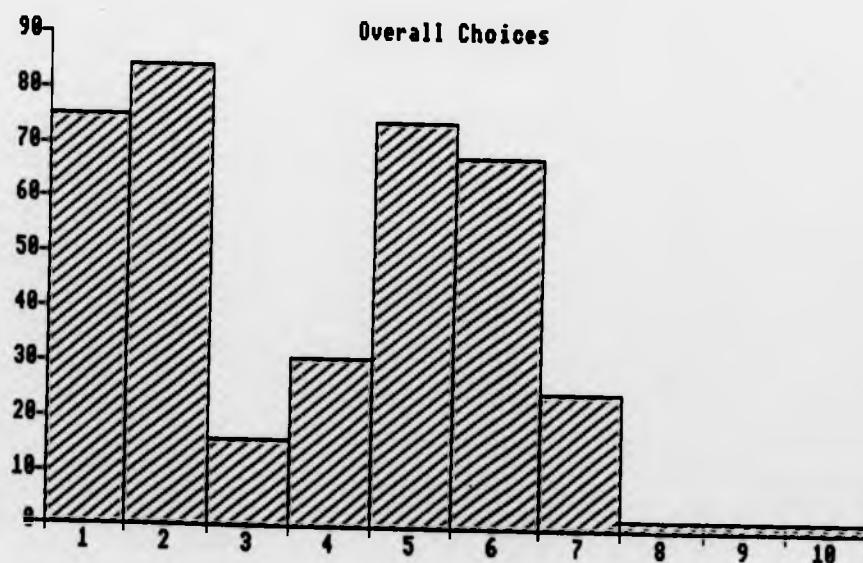


Figure 6.13

A comparison of methods by which information is received by the three sub-groups in the survey, and between Comprehensive and Independent schools, revealed no significant statistical difference between them.

Q14 Educational publications read regularly

The incidence of educational journals read by teachers is summarised in Figures 6.12 and 6.13 under first choice, first three choices and overall.

Nearly all (97) teachers read some journal regularly, with first preferences being almost equally expressed for Education in Science, School Science Review and the TES. When the first three choices are considered, the TES falls a clear third behind the other two (47 cf 71 and 75 respectively), with the Institute of Physics' Snippets (41) being almost as popular. The same trend is present in the overall analysis.

If one compares the most important source of information with the journals read (C29/C33), the TES is read by some 38% of those who consider 'reading journals' the most important source (24), and by 24% of those who placed 'by post to your school' first (55), the same trend is true of Education in Science, though School Science Review is read equally by the two groups.

In the overall analysis (C29/C33-38), the TES was a less important source than the three equally important sources Education in Science, School Science Review and Snippets.

There was no significant difference in the reading preferences of the three sub-groups within the survey, nor between Comprehensive or Independent schools.

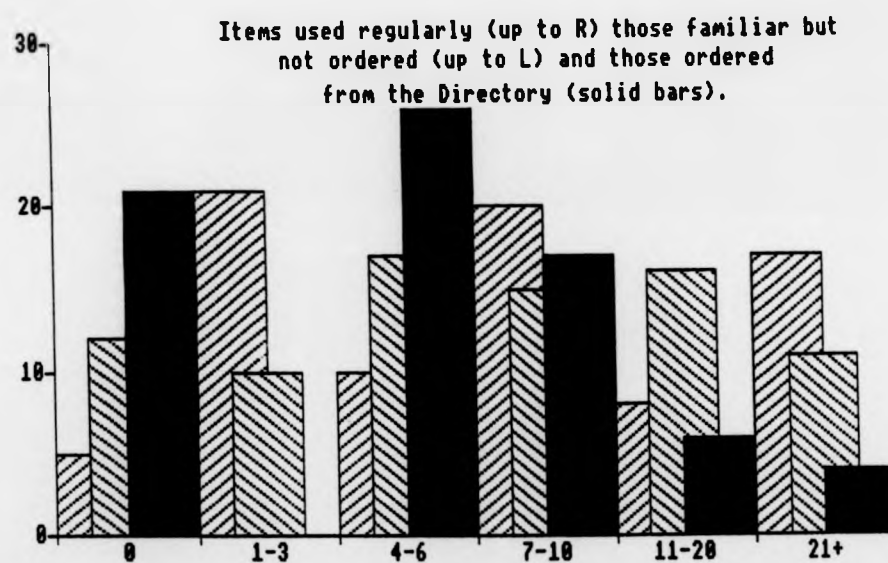


Figure 6.14

TEACHERS' RESPONSE TO THE MATERIALS AND TO THE DIRECTORY

N.B. Some 10 teachers specifically replied that they had not had a chance to go through the Directory, or to decide on which materials they would like to order, before returning the questionnaire. Eighteen teachers made zero returns for C41-47. It is extremely unlikely that they previously knew of no materials included in the Directory, so one has to assume that they returned the questionnaire without considering the items in the Directory. Seven further teachers did not complete answers for C45-47. Their statistics were discounted when calculating the relevant averages in the sections below.

Q15 Items already used or hired regularly

The distribution of previous usage of materials is shown as one of the elements in Figure 6.14, corrected for missing responses. The average number of items already used or hired regularly was calculated using the means of the frequency intervals and lay between 8.0 and 10.4 items. Of those who apparently completed this question seriously, only five of the eighty-one (6.2%) were not aware of any of the materials included in the Directory in advance.

The average number of materials known by teachers in Comprehensive schools was 9.8, towards the upper end of the overall range of values. There was no significant difference when comparison was made by school size (C7), by entering candidates for examination at 16+ (C19) or teaching at 'A'-level (C21). There was some indication that teachers became aware of more items after their first two years' teaching (overall av 8.2 cf av 3.0 for first two years), with a slightly larger than average value (10.8) for those teachers with 11-20 years' experience.

Although the Leicestershire schools represented only 10% of the sample, their previous use of material was significantly lower (av 4.2 items) compared with the Warwick (av 10.0 items) and the ASE (av 8.7) groups. The fact that they had not taken the initiative of either enquiring about the Process Curriculum or ordering the Directory may be a relevant factor.

Q16 Known materials which teachers had decided previously not to order

This second element in Figure 6.14, corrected for missing responses, shows that the distribution was very similar to that for Q15 and gave an average which lay between 7.3 and 10.3, virtually the same range. A comparison of C41 with C43 showed that in nearly every frequency interval, teachers had already decided not to order almost exactly the same average number of items as they were already using. Those who used more items (>11), generally decided not to order rather fewer items. The implication is that, given a particular commitment to and interest in industrial materials, teachers tend to reject a fixed proportion of those available, possibly on the grounds of cost. This is considered in the next section but one.

A comparison of the averages for C41 and C43 (10.4 and 10.9 respectively) shows that about equal numbers of materials were used regularly as not ordered after consideration, and was reflected in the average numbers when examined by experience of the teachers involved. This implies that for the sample represented in the survey, only about 50% of the subgroup of materials deemed relevant to teachers of physics by the Editor, were considered sufficiently so to be worthy of purchase by teachers! This could be interpreted either as poor selection by the editor or as

some factor of the materials themselves, such as pricing policy or the readiness with which they can be used in the classroom situation. The first factor is discussed under Question 18 below, the second cannot be informed by the responses to the questionnaire, though qualitative indications that this was the case emerged in talking to teachers in the pilot study. The Directory materials were already a small sub-set of all the materials produced by companies. A maximum average of only 10.3 items, 20.7 for C41 and C43 together, indicates that teachers are not generally well-informed about what materials are available. This must, at least in part, be a consequence of the advertising policy of the producers.

The Warwick Process group of teachers, although not significantly greater previous users of materials in the Directory than the ASE group (av 10.0 cf av 8.7), had decided not to order about twice as many items (av 11.3 cf av 6.5), indicating that the Process group were generally better informed about materials (av 21.3 cf 15.2). This could be because the ASE group ordered the Directory, having reservations about their knowledge of materials, while the Process group were teachers broadly interested in innovative trends.

Q17 The number of items ordered as a result of receiving the Directory

Some 46 teachers left this response blank or wrote 0, and this correction is made in Figure 6.14. As mentioned above, this figure should perhaps be about 21, given that half of those who had not had the opportunity to make a selection would eventually not order the average number of items. As might be expected, more ordered fewer items, the average lying between 5.0 and 7.2. Unfortunately owing to an over-sight, the frequency class 1-3 was omitted from the

key for this question and it is difficult to know whether this will have inflated or deflated the average. For at least 27 of the teachers, the Directory led them to order more than 7 items.

A comparison of C45 and C41 showed that teachers previously using more than ten items from the Directory ordered about 60% or more of this number of items from the Directory, and a rather larger percentage if previously using more than eleven items. This indicates that rather than encouraging those who used few items to order, those with an established usage were prompted to order more. Similarly, a comparison with C43 showed that the more items teachers had previously decided not to order, the more items they were moved to order on receiving the Directory. Those who ordered most heavily (4 teachers ordering >21 items) were lower than expected both on previously familiar items and on the number they had previously decided not to order. For these teachers, the Directory may have provided the stimulus to use more industrially produced materials.

The average number of items ordered by teachers in Comprehensive schools was 6.2 compared with 4.5 for teachers in Independent schools, but only 6 teachers responded to this part of the questionnaire, so little may be inferred from these figures.

Size of school did not seem to influence the number of items ordered, though a comparison with teaching experience revealed a significantly high average number ordered by those with up to two years' experience (9.4 cf 6.1), perhaps compensating for their limited previous use and knowledge of materials? Producers might well look to training colleges and University Departments of Education as a way to increase the awareness and uptake of their materials by new teachers. This suggestion will be pursued

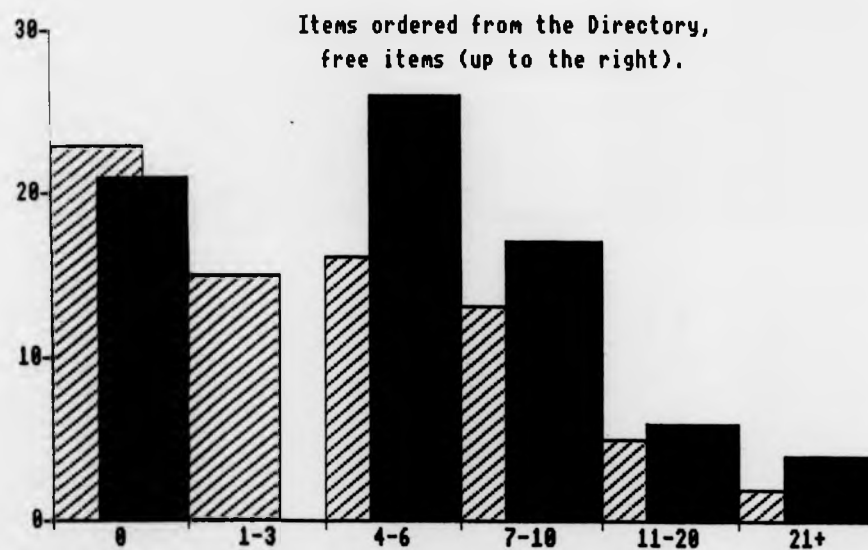


Figure 6.15

in Chapter 11.

There was a small, but perhaps not significant, difference between the survey sub-groups in their ordering of items as a result of receiving the Directory, although their previous knowledge and use of materials was significantly different, as shown below. The Leicestershire teachers who responded, ordered a larger average number and percentage of previously familiar materials than the other two groups. Since they represented a small minority of that sub-group, it is possible that they were amongst the keenest about such materials.

Survey Group	1	2	3
Knowledge and use of materials	av 10.7	av 21.3	av 15.2
Materials ordered	av 8.4	av 6.8	av 5.2

Q18 The proportion of items ordered which were free

The number of items ordered and those which were free, corrected for missing responses, are compared in Figure 6.15. Of the average number of items ordered (6.1), the average number which was free (4.7) represents 77%, compared with 58% free items in the Directory as a whole. As far as can be judged from comparing C45 with C47, 60% (for the 4-6 items interval) is the smallest, while 91% (for the 7-10 items interval) is the largest percentage of items ordered which was free. So teachers never selected fewer free items than they would have done without regard to the cost, and often substantially more. It should be stated that when analysing the number of free items ordered by experience of teachers, one group's percentage of free materials (those with 6-10 years' experience) exceeded

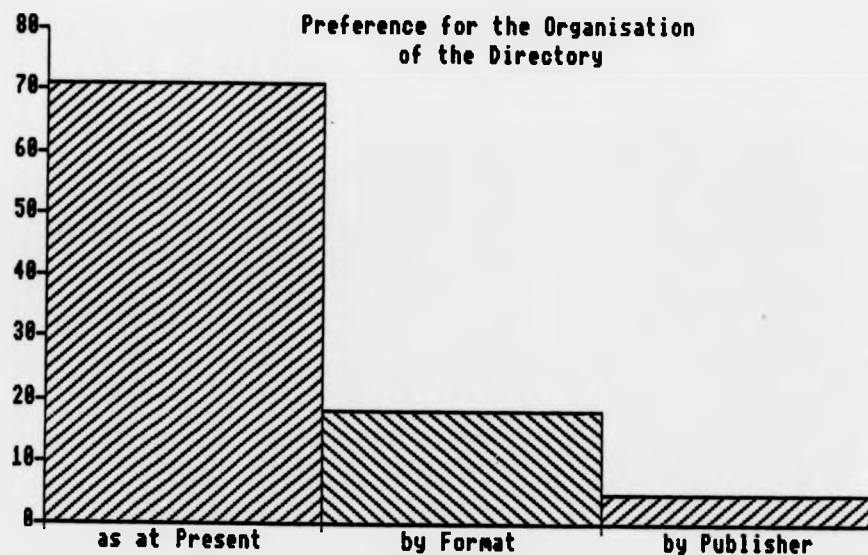


Figure 6.16

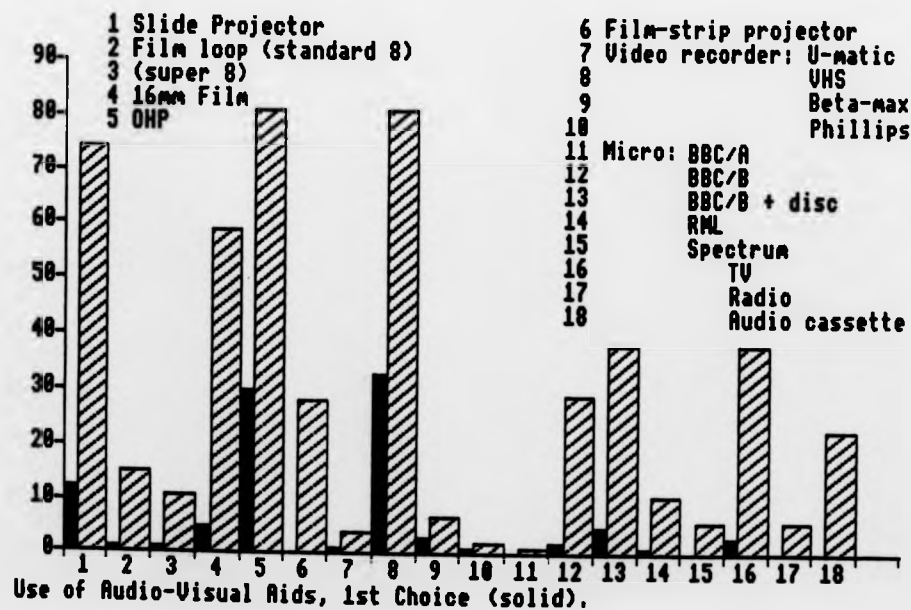


Figure 6.17

100%. These were of course average values, calculated using the means of the frequency groups, and this probably accounts for the discrepancy.

When an analysis of C47 by C1 was carried out, 79% of materials ordered by teachers in Comprehensive schools were free, compared with 51% for teachers in Independent schools. The number of Independent school teachers was too small to test the significance of these values, but there may be some indication that they have more resources available over which they have direct control, a factor confirmed qualitatively in discussion with teachers during the pilot study.

Q19 Format of the Directory

As Figure 6.16 clearly shows, teachers overwhelmingly preferred the present arrangement of items within the Directory.

TEACHERS' USE OF VISUAL AIDS AND INDUSTRIAL MATERIALS

Q20 Visual aids used in teaching

The incidence of the most frequently used visual aid is shown in Figure 6.17. The VHS video-recorder (33) and the over-head projector or OHP (30) were the most popular, with the slide-projector coming third (12). None of the others had more than 5 teachers preferring them. The statistics of the first choices are also shown in Figure 6.20. The leaders remain the same, but the BBC microcomputer, chiefly in the B and B+disc versions, and the 16mm film begin to emerge as popular aids. To these are added in the overall choice, television, the film-strip projector and the audio-cassette.

Ten times as many teachers used VHS as any other type of video format, and the BBC was by far the most popular micro, the A version not being used, and the B version with disc being twice as popular as the B without. Radio programmes were very little used, perhaps because there are not many in the field as yet.

A comparison of the visual aids used by the different sample groups within the survey, revealed no distinction on first choice or first three choices; they were much in line with the survey findings as a whole. However, the group who bought the Directory from the ASE used the slide-projector most overall, though only marginally behind the OHP and the VHS video.

No matter what the experience of teaching physics (C11), the most-used apparatus choices were the same: OHP, VHS video and slide-projector. When compared with the first three preferences (C51-55) the same pieces of apparatus were selected, with a slight indication that teachers new to the profession (1 to 2 years) are more likely to use videos (33%) than their senior colleagues (most prevalent 27%), and exclusively VHS, whereas teachers of eleven years' standing or more used all four formats of video. Overall, the three 'front-runners' were used almost equally by teachers regardless of experience.

For the most experienced group (>21), the BBC micro featured more often than any other single category of apparatus, perhaps surprisingly? There appeared to be no link between the experience of a teacher and the variety of apparatus used, as indicated by at least three choices (C11/C55).

An examination of whether the length of lessons affected

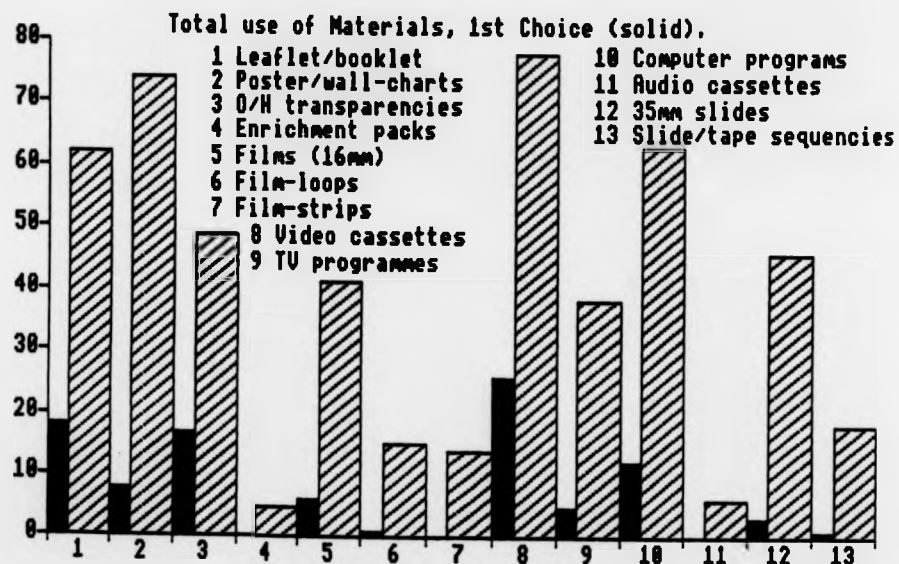


Figure 6.18

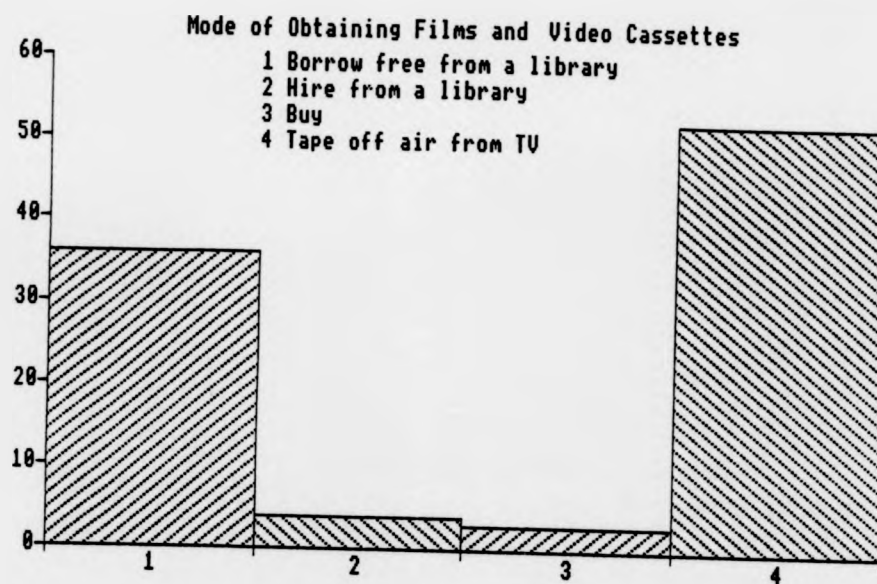


Figure 6.19

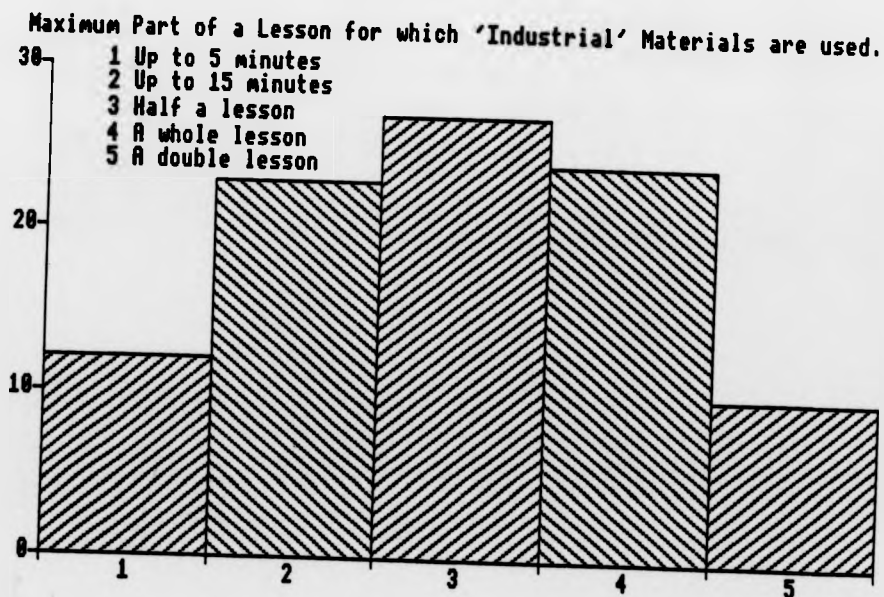


Figure 6.20

which apparatus was the most used (C27/C51), showed that there was no significant correlation.

Q21 Materials used in teaching

The formats of teaching materials used are shown in Figure 6.18. Video cassettes were clearly in the lead for both first choices, first three choices and overall, while posters/wallcharts, leaflets/booklets, OHTs and computer programs/simulations occupied the first four places on the first three choices (C63-67). When analysing the whole of the responses (C63-73), 35mm slides were fifth in popularity and TV programmes and 16mm films were also significant materials.

An attempt to correlate the maximum time for which materials had been used (C78) with choice of materials (C63-C73) was unsuccessful, as the use of video cassettes, films and computer programs was so marked, it swamped any trend.

Q22 Method of obtaining films and video cassettes

The majority (52) tape video cassettes off air, as shown in Figure 6.19, presumably legally as schools broadcasts or under Open University licence, and 36 borrow them free from a library. Very few hire or buy video tapes, despite subsidised videos being made available by ICI, BP and others at low cost.

Q23 The maximum time for which industrial materials are used in a lesson

The distribution for the maximum part of a lesson for which 'industrial' materials had been used is shown in Figure 6.20. There is some indication that very short times (<5

minutes) and long times (double period) are avoided. Films and videos were excluded because they would usually last for at least a single lesson and obscure any other trend.

A comparison of maximum time of usage (C78) with the use of particular materials (C63-C73), revealed rather greater use of leaflets/booklets by those using materials for greater maximum times and greater use of over-head transparencies by those who use materials for shorter maximum times. Overall, however, the use of particular materials seemed to be independent of the maximum time for which materials were used.

CHAPTER 7

A CRITICAL REVIEW OF TWO STUDIES INFORMING THE FINDINGS OF
THE QUESTIONNAIRE SURVEY

As was mentioned in the previous chapter, the relatively small sample of teachers approached by the survey requires the indications and conclusions summarised in the last eight paragraphs to be treated with caution until a more wide-ranging and systematic survey can be undertaken. Two sources of survey material were helpful in informing and confirming the findings of the previous chapter:

1) a nationally based survey, commissioned by the Department of Industry and carried out by the Roehampton Institute, University of Surrey during 1985 into teachers' use of IPRM (Industrially Produced Resource Materials) (DICKER 1985).

2) Survey of Viewing in UK Schools 1982-1986 conducted by The Educational Broadcasting Services Research Unit (EBS 1982/3/4/5/6). These annual surveys, into teachers' use of television in their teaching, constitute one the most detailed summative evaluations of material produced for schools by commercial concerns.

1. THE USE OF INDUSTRIALLY PRODUCED RESOURCE MATERIALS IN
SCHOOL SCIENCE AND MATHEMATICS TEACHING

Through pilot interviews with teachers and a national survey of schools, the enquiry sought to gather information under the following heads:

- a) the possession and use of IPRM by school science departments.
- b) pupils' preferences for resource material.
- c) the factors influencing the discovery, selection and rejection of IPRM by teachers.
- d) the reasons teachers had for wanting to introduce IPRM into their teaching.
- e) science subjects and topics requiring IPRM.
- f) the contents of an 'ideal' resource pack.
- g) a case-study of good practice in one secondary school.

In a separate postal survey, the role of Science Advisers in promoting the use of IPRM amongst teachers was investigated.

Sample interviews with teachers

Much illuminating information was obtained from interviews with some twenty teachers selected by canvassing all secondary schools in Surrey, in the form of "anecdotal" comment. Since the low initial response demanded an extension of the random sample to all those who responded to a county-wide appeal (DICKER 1985, p.5), the results are little more than "suggestive" of teachers' views, but served to inform the design of the questionnaire for the National Survey.

The significance and use of IPRM

From the point of view of the present author's Directory Survey, the following comments are significant as confirming that for some of these teachers at least, IPRM does not make a significant contribution to their teaching.

'There was no example ... of a significant extent of use of

IPRM throughout the departments of science and mathematics' (op.cit., p.7). 'In many schools, the teachers recognised that they did not make full use of the IPRM that was readily available' (op.cit., p.7). ' "[I] have not used IPRM much before because it hasn't been highlighted on the syllabus ..." ' (op.cit., p.8). 'One teacher interviewed said that little IPRM was used because they were: "... not falling over it." ' (op.cit., p.9).

The answers to Question 15 of the Directory Survey indicated that items used or hired regularly by teachers, or known to them, represented at most 9.2% of the Directory entries, perhaps 2% of the IPRM examined in preparing it, which is consistent with little IPRM being used in general as indicated above.

Postal advertising

As regards finding IPRM, when referring to the process of receiving information through the post, two teachers described the process and its consequences.

"Little random, depends on the advertisers rather than on us actually going out looking for material." "[I] have a barrage of information, therefore [it is] not easy" (DICKER 1985, p.10).

The general impression gained was that 'so much paper arrives on a teacher's desk that it is consequently very easy to commit it to the waste paper bin or filing cabinet without even a cursory glance' (DICKER 1985, p.11). The answers to Question 13 of the Directory Survey indicated that 'by post to your school' was the pre-eminent, principal method by which teachers received information about IPRM, but it would seem, from this sample at least, not to be very effective.

'Teachers' Centres and Resource Centres were not referred to during these interviews as a means of finding out about IPRM.' (op.cit., p.11), which is consistent with Question 13 of the Directory Survey indicating that only 7 of the 99 sample schools included 'at local teachers' centre' as one of the three most important sources of information about IPRM.

The pricing of IPRM

Teachers' comments included the following.

"[I] ... take anything free or cheap. Most of capitation is spent on apparatus." "Where it doesn't cost a lot then we are interested. ..." (DICKER 1985, p.15). "... even freely available films require postage to send it back - too much to keep doing it. ..." "If material costs, we will only buy after seeing it, and even then the amount is limited." (op.cit., p.16).

Analysis of the answers to Question 18 of the Directory Survey indicated that there was a preference for free materials, but perhaps not so exclusive a one as the above quotations might seem to suggest. See also the analysis of the responses to Question 10 of the National Survey below.

General points

In addition to these specific points, general comments were solicited about two areas which have relevance for two of the successful projects described in Chapter 9 of this thesis: the likely use to be made of a computer data-base, accessible by telephone, to inform teachers of IPRM (OVERTURE and NERIS); and improvements to IPRM, most of which indicated the perceived importance of

teacher/industry links in the production and writing of materials (three of the other projects covered). The criteria for the selection and rejection of IPRM are more fully explored in the National Survey and will be examined in the next section.

Science Advisers' role in informing teachers about IPRM

A postal survey carried out of Science Advisers received a 17% response rate - about the same as the National Survey of schools. It is tempting to speculate about the reasons for the low response, but judging from the replies received, it seems most likely that few advisers take an active part in bringing IPRM to teachers' attention; most relying on direct mailing by the producing companies and teachers visiting a resources centre, often housed at the local teachers' centre. One or two advisers adopt a range of effective strategies for promoting IPRM, among them informing teachers through:

- resource and teachers' centres, and SATROs.
- LEA circulars and newsletters, resource handbooks,
- meetings within the LEA, INSET and other courses,
- study groups,
- personal contact in school.

(DICKER 1985, p.27).

The National Survey of schools' use of IPRM in science

All secondary and secondary middle schools in the country were sent questionnaires in September, 1985. A total of 1328 (18%) replies were received.

The responses to Question 1a, about possession and use of

IPRM (DICKER 1985, Figure 1, p.33), indicate that few schools in the sample did not have a single booklet or wall-chart available (<5%) and only 18% did not have films/videos 'available'. The analysis of replies to Question 21 of the Directory Survey, summarised in Figure 6.21, similarly indicates a high usage of leaflet/booklets and poster/wall-charts, but on overall use, video cassettes exceed and computer programs equal their usage. On a 'first choice' basis, video cassettes are the clear leader (25%) with OH transparencies (16%) rivalling leaflet/booklets (18%), while poster/wall-charts (7%) were less popular than computer programs (12%). Several reasons for the apparent disagreement between the responses to the two surveys may be identified.

Firstly, Question 1a was exclusively directed at 'materials produced by industry' whereas Question 21 just asked 'Which formats of material have you used in your teaching?'. If the aim of the question is to elicit the kinds of materials teachers are willing to use, so as to inform producers of industrially based material, then the more general question would seem more appropriate, since the response will not be coloured by the formats of material already available from industry. An analysis of the formats of the materials included in the Directory reveals that 27% are leaflet/booklets, 23% films (16mm) and 18% video cassettes (total 41%), 11% film-strips/slides and only 8% wallcharts. There was not a single example of software, though BP, British Gas and others have subsequently entered this market. The responses to Question 20 of the Directory Survey, indicate that few schools are without access to a micro-computer (predominantly BBC-B and RML, which given the DTI funding is to be expected) and that the obstacle to the use of software would appear to be its incidence as IPRM: nearly 60% of schools in the National Survey did not have any available. Although the Directory Survey replies

were drawn from a very much smaller sample and should be viewed with corresponding caution, it would seem that teachers' replies may have been coloured by the range of IPRM formats available and that industry may not be providing teachers with those formats which they would otherwise use frequently in their teaching.

Secondly, a feature of Question 1a concerns the eliding of films and videos into one category. The indications of the Directory Survey are that 16mm film is used in roughly half the number of schools which use video cassettes, which has a message for producers of IPRM. Some teachers may have made a negative response in the film/video category because they felt that hiring a video or film did not qualify as its 'being available in your school' (DICKER 1985, p.84). The omission of OH transparencies and TV programmes from the list of choices is unfortunate, as teachers make considerable use of these and producers might welcome information about the potential market for materials produced in this format.

A positive response to the categories of Question 1a, as to Question 21, may imply that a school has as little as a single example of a particular format available. The important feature is the frequency with which a particular format is used. In the National Survey, Question 1b asked teachers to grade their use of each of the specified formats from 'frequent' to 'never' on a five point scale (DICKER 1985, p.84). The fifth point 'never' would seem to be redundant, as the percentages are exactly complementary (as far as the resolution of Figures 1 and 2 (op.cit., pp. 33 & 34) allows). Clearly, if a school does not have access to a particular format of material, its frequency of use must be described as 'never'. It would have been interesting to know the frequency distribution if those schools without the format concerned had been eliminated by

the computer before the 'Frequency of Use' had been calculated. This information is implicit in the first four frequency intervals in Figure 2 (op.cit., p.34), but again one must exercise caution in interpreting the relative frequencies with which various formats are used because they are possessed in very different measure for schools as a whole. Specification by percentage of schools having the format available would have informed the relative value of each format of material. The tables were presented without comment at this point in the report.

Question 3 of the National Survey explored how IPRM was used by teachers, and pupils' response to it (op.cit., p.85). The writers conclude that IPRM is mostly used for 'traditional', passive activities within the classroom and little for project or laboratory work. This, despite the fact that 'resource packs' were possessed by over 65% of responding schools (DICKER 1985, Figure 1, p.33). The response to Question 21 of the Directory Survey showed the number of schools using 'enrichment packs' (5%) was the smallest of all formats. Perhaps the Directory Survey sample was not typical of the whole population, or there was confusion over what the terms 'activity packs' and 'enrichment packs' imply. The availability of such packs directed towards science is not great and often the contents may be appropriate for collective and 'traditional' activities, rather than individual or extension work. Several producers do provide material which generates practical work and directs student experiments, and the quite sizeable proportion of schools using IPRM for 'laboratory activities' (38%) indicates that further examples would probably be well used. This is borne out by a recent highly successful project Experimenting with Industry (SCSST/ASE 1985).

In terms of pupil preference, films/videos and computer

software were rated as popular by nearly all the schools which used them, while booklets were rated as popular by about two-thirds, slide/tape packs by half and wall-charts and activity packs by under half of schools that used them. The authors give as possible reasons for the popularity of films and video tapes: 'pupils ... prefer those types of material ... where they are least active', '... because [pupils find] they are visual, interesting, stimulating, easy and a change from the normal types of classroom activity' (DICKER 1985, p.36), but this is as true for tape/slide packs as for films and videos. One suspects that a more cogent reason is that 'they (youngsters) see good quality programmes on television and are familiar with acquiring information through this medium' and that they are consequently intolerant if 'any material is of poor-quality and out-of-date' (op.cit., p.36). Since pupils' experience of television seems to be a significant factor in their interest and liking for videos and films, it is a pity that producers of IPRM have not engaged more actively with the television companies in generating IPRM in this format.

As mentioned above, booklets and wall-charts were not so popular, and teachers reported that although they could be interesting, colourful, be used for individual learning and provide a contrast to normal classroom activities, booklets could be vehicles for advertising or even propaganda, and wall-charts could be too detailed and soon merge into the background.

Computer software seemed to be universally liked by pupils who had access to it, though it was not clear whether in the context of individual or class use. Other materials were most popular if they allowed a pupil to work at his or her own pace.

Question 6 of the National Survey asked teachers how they found out 'what industrially-produced resource material is available' (DICKER 1985, p.86), a parallel to Question 13 of the Directory Survey, though there was no implication of frequency or consistency in the use of the stated source in the question and no way to gauge these from the responses. As the percentages show, schools and teachers receive information by a variety of mechanisms, the most important by far being direct from the producer by post to the school. Some 84% of schools reported receiving information in this way and 73% through reading journals; very similar percentages to those polled in the Directory Survey, though there, more than twice the number of teachers rated 'by post' as the 'most important source' compared with 'reading journals'. By the National Survey's not including the Education Guardian and Snippets as separate responses, teachers were polled on one only of a range of resources. When asked specifically about publications they read regularly, and to rank them by frequency, (Question 14 of the Directory Survey) about one third of the teachers ranked the ASE journals SSR and Physics Bulletin and the TES as their most frequently read publication. When looking at overall readership, the Institute of Physics Snippets was clearly read by a large number of physicists, though this clearly only has relevance for producers of IPRM directed towards them.

The importance of journals for promoting IPRM should not be overlooked by producers. In particular, SSR and TES have reviewing facilities which if affording a favourable review (!) should help in encouraging teachers to obtain the material.

The third most quoted way in which teachers gain information about IPRM was 'courses/conferences etc.'. It is not clear from the question structure whether these are

locally based courses, run by the LEA Science Adviser, or nationally-organised conferences such as the Annual Meeting of the ASE. The responses to Question 13 of the Directory Survey suggest that the ASE Annual Meeting is as important as Science Advisers and Heads of Department as a way of gaining information. Of course, the National Survey was of Heads of Department, but Science Advisers are the least quoted source of information, falling even below teachers' centres, which in the Directory Survey ranked very low, together with a school's resources centre.

A category which was not included in the National Survey, 'by writing to companies' came third, behind only 'by post to your school' and 'by reading journals' in the Directory Survey. This is a high incentive method for teachers, and producers would be well advised to ensure that they both encourage teachers to write for information and that they appoint staff who are able to select from the wide range of materials they produce those which most nearly meet teachers' needs.

Question 4 of the National Survey investigated the criteria by which teachers select or reject IPRM. This is clearly of paramount importance for informing producers of material about teachers' requirements. Ten dichotomous pairs of characteristics were presented as criteria for selection and rejection by teachers, having been generated from the more informal interview phase of the Survey. Teachers were then asked to rank the five most important and a score of 100:80:60:40:20 was given to the characteristic chosen 1st:2nd:3rd:4th:5th, 0 being awarded to any characteristic not ranked 1-5. The 'rating' for a characteristic was obtained by finding the mean score for responses from all questionnaires. (See DICKER 1985, p.42 for a full description of the methodology.) The results of the analysis are presented in bar-chart form (op.cit., Figure

4, p.41), with the 'rating scale' marked as a %. Given the above method for calculating the 'rating', the result is clearly not a percentage, but a score indicating the mean ranking given to a characteristic by the teacher sample. The statistic is interpreted in the text as the percentage of teachers believing that the material they acquire should have the characteristic specified (op.cit., p.42, paragraph 2). This is an unfortunate confusion as can be seen from an extreme case. If all teachers rated a characteristic 5th, then it would be given a rating on the scale of '20%' and the interpretation made that 20% of teachers believe that the material they acquire should have that characteristic, whereas, 100% of teachers feel it should have that characteristic, but rank it only fifth compared with other more important characteristics. However, the interpretation of the data in enabling the characteristics to be put in rank order for the 'average' teacher is still valid.

Relevance to the curriculum was regarded as the most important criterion for selection, good visual presentation second, while material being available at no or low cost and having a suitable language level, were almost equal third and fourth. As regards characteristics for rejection, again, lack of relevance to the curriculum, expense, unsuitable language level and poor visual presentation were ranked in the first four places.

The differences in the ratings for a characteristic's meriting selection or rejection may provide evidence that material is also acquired for non "core" teaching, when irrelevance for the curriculum may not cause rejection, and that too difficult a language level and expense are stronger disincentives than their counterparts are incentives. The provision of class sets of IPRM did not seem to sway teachers to select the material.

Question 10 of the National Survey (DICKER, p.87) explored the amount of money teachers could afford from their budget to purchase 'a typical pack of ... material'. They were asked to choose from five over-lapping ranges: nothing, £1-£2, £2-£5, £5-£10 and £10-£20. Approximately 50% of schools indicated that they were able to pay less than £5 for a pack, though 24% could afford up to £20 for a pack (Figure 5, DICKER 1985, p.44). This was for a single pack, and various caveats were made, such as the precise contents of the pack, whether it was available in class sets, the quality of the material and the time in the budget year that the purchase was being considered. This indicates that the raw data must be treated with caution. An interesting observation concerning pricing from an evaluation of a BP resource pack is that 'it could be that a considerable increase [in cost] will put ... [resources] out of the reach of those teachers who buy them out of their own pockets' (SCOTT & LLOYD 1979, p.14). The analysis of the replies to Question 18 of the Directory Survey, indicates that teachers never selected fewer free items than they would have done if their selection had been made without regard to cost.

The final section of the National Survey considered teachers' views of the need to use IPRM and how it might be improved and developed. 76% of the sample indicated that they thought more IPRM should be introduced into their teaching, citing in free response amongst other reasons: to '... show the applications of science', 'that the syllabus requires industrial contact', 'that there is a need to relate science to the outside world', 'that IPRM is up to date', and 'that it has no, or low, cost' (op.cit., p.47). 21% held that schools already possessed enough of this material, citing amongst other reasons 'that the time required for teaching curriculum material would not permit its use', 'that enough IPRM is already available in

schools' and 'that the syllabus does not warrant its use'.

The free response reasons advanced by the 21% for not wanting to introduce more IPRM into their teaching contrast with the most important characteristic for selecting material i.e. relevance to the curriculum (reported as regarded as important by 81% of teachers, but see above). There seems to be a contradiction in these attitudes, and it may be that teachers interpret syllabuses differently; the majority seeing IPRM as a way to expand and meet the increasing demands of syllabuses to demonstrate applications and social relevance of science, and the minority feeling that pressure of the syllabus precludes any expansion in these ways. It seems likely that the advent of GCSE with its explicit requirements in these areas will increase the demand for IPRM still further. There is also the implication that a teacher's 'curriculum approach' may be modified by the use of industrial materials, and a suggested model to allow an analysis of this process is outlined in Chapter 12.

Question 7 of the National Survey asked teachers if and how IPRM could be improved (DICKER 1985, p.86). 81% of teachers said that it could be improved, and suggested the following actions: 'to match material to pupil age and pupil level/ability and consider the language used', 'to relate IPRM to the curriculum/syllabus', 'to use teachers in the preparation of IPRM' and 'to simplify IPRM'. It was reported that there was a general feeling that the material was not targeted sufficiently accurately to specific age-ranges of pupils, that it should be more visual, colourful and less detailed and that teachers would like to see the inclusion of basic scientific facts and principles relating to the subject being considered. It was felt that many of these aspects would be helped by using practising teachers in the production and trial of the materials. This

is a strategy which has been adopted successfully by several of the case-studies outlined in Chapter 9 of this thesis.

It was also reported that teachers did not appreciate the approach by some organizations where 'material is more a form of advertising ... (to persuade) readers of the merits of a particular industrial process without any real consideration of the disadvantages'. This criticism was frequently made of the atomic energy industry. Only 9% of teachers indicated that IPRM was without need of improvement.

Teachers were finally asked to suggest the contents of an 'ideal' resources pack. Not surprisingly, there was little consensus in the replies received, though the formats most frequently requested were those most often provided by industry as judged by sample pages of a reference handbook of currently available resources for teachers. The proportions of the various formats available, corresponded closely with those included in the Directory of Physics Resources (BULLETT 1985). The most important demand was for co-ordination between items in the pack and flexibility, 'without neglecting an oversight of the global scientific principles and concepts for which it is being used' (DICKER 1985, p.57).

An example of good practice of the use of resources in a secondary school

The final section of the Dicker report was a detailed description of the practice in one Hertfordshire secondary school of the use of resources. This involved the wide use by teachers of a resource centre, which had a large reserve of book and non-book materials. Pupils' use of these materials was structured by work-sheets and annotated

references written by teams of teachers working within and across traditional academic departments. These materials often relied heavily on IPRM, and the model operating in this school is perhaps a good one to show how IPRM which is unsatisfactory in its raw state, and does not meet the needs of a teacher or institution, may be modified and made "user friendly" by the use of teachers' professional expertise. However, the message for producers of IPRM is that teacher collaboration at the writing stage will increase the likelihood that the material will be used by teachers directly in the classroom and that its format should be flexible enough to allow it to be used in many different ways.

2. SURVEYS OF LISTENING AND VIEWING IN UK SCHOOLS. 1982-86.

This double series of reports (EBS 1982-86 A & B) concerns comprehensive surveys which are carried out three times a year to inform the producers of schools' educational broadcasts about a wide range of issues which affect a school's uptake and use of these broadcasts for radio and television. Besides viewing and listening figures, information is gathered about the provision of audio-visual aids and teachers' access to them.

The statistics which have been generated over this four year period allow certain trends to be observed, and the figures obtained in 1985-86 provide a datum against which to compare the statistics resulting from Questions 20 and 21 of the Directory Survey (Chapter 6).

Question 20 concerns the availability of visual aids for teaching on more than an occasional basis. Teachers were asked to rank up to six from the prescribed list in order of decreasing frequency of use.

of the 99 schools surveyed, 80 included OHP and VHS video-recorder, and 74 slide-projector amongst their six choices. With the exception of 16mm film (the use of which the EBS surveys do not cover) these were the clear leaders, some 32% of the sample placing VHS video-recorder and 30% OHP as their first choice, only 12% placing slide-projector first.

The EBS's (Educational Broadcasting Services) Survey of Listening statistics indicate that in the Spring, 1986, 99% of sample secondary schools possessed an OHP (EBS 1986A, p.26), with perhaps as many as 90% of science departments having their own, or regular access to one. As early as the Summer of 1982, 96% of the secondary schools surveyed possessed a video recorder, the figure rising to 98% the following summer (EBS 1982/3B, p.4) and remaining at 99% from Autumn, 1983 (EBS 1983/4A) to the last available figures for 1986. It is interesting to note that in the survey for Spring 1986 it was found that the average number of video-recorders per secondary school was 3.5 (EBS 1986B, p.3) with 29% of the sample having more than four per school (EBS 1986B, p.5), and that 80% of schools possessed slide-projectors used with a carousel (EBS 1986A, p.26), with the proportion of science departments having their own, or regular access to a slide-projector being inferred as well in excess of 50% (SYMONS 1987). It is interesting that the overall statistics for a school's ownership of a/v aids may be misleading if taken as a science department's provision. The first-choice statistics of the Directory Survey may well reflect the availability of the audio-visual aid as much as genuine preference.

As regards the system of video recorder, VHS has led since figures were first collected (1982): 73% (VHS), 13% (beta-max), and 5% (Philips 2000) of secondary schools

possessing video-recorders in the Autumn of 1982 (EBS 1982/3B, p.5) and 90% (VHS), 14% (betamax) and 11% (Philips 2000) in Spring, 1986 (EBS 1986B, p.7). The percentages of schools in the Directory Survey (1985) including the particular formats of video-recorder in their first six choices of v/a were 81% (VHS), 7% (betamax) and 2% (Philips), so it would seem that these figures are in line with national trends and that the majority of schools have access to a VHS machine.

The next most popular group of a/v aids which Question 20 of the Directory Survey revealed was the micro-computers. 38% included BBC/B + disc, 28% BBC/B, 10% RML and 7% Spectrum among their six choices, with first-choice preferences following the same pattern. The SLV surveys show 98% of secondary schools to have had a micro-computer since the Summer of 1984, with the average number of machines per school rising from 9 then (EBS 1983/4B, p.7) to 14 in the Spring of 1986 (EBS 1986B, p.8). Nearly one third of all schools possessed more than 15 machines and 19% more than 20 (EBS 1986B, p.10). In 1985, 42% of secondary schools which possessed micros also had them networked (EBS 1985B, p.16).

As regards the variety of micro-computer, the BBC machine has been leading the field ever since figures were first collected (EBS 1983A), the comparative figures for equipped secondary schools for Summer, 1983 being BBC/A or B 62%, RML 52%, Sinclair Spectrum 43% and other 49% (EBS 1983/4B p.8) and for Spring, 1986, BBC/A and B 92% (BBC/B 89%), RML 58%, Sinclair Spectrum 23% and others 41% (Commodore PET 13% of these) (EBS 1986B, pp.12 & 13).

The picture about the method of storage used by schools for files and programs has changed considerably over the period of the quoted surveys. In the Summer of 1983 13% of

equipped schools used disc only, 15% cassette only and 72% both (EBS 1983/4, p.10). By the Spring of 1986, 33% used disc only, 2% cassette only and 65% both (EBS 1986B, p.14). 41% of those using disc were intending to standardise on 40-track format and 19% on 80-track (EBS 1986A, p.19).

The pre-eminence of the BBC/B machine and the proportions using disc are reflected in the responses teachers made to Question 20 of the Directory Survey.

Television was ranked equally highly with microcomputers overall, and the surveys show the percentage of schools using educational broadcasts to have stayed in the high nineties since 1982. The percentage of schools using specific science broadcasts for the 11-16 age-range was between 30% and 40% in 1986 for both BBC and ITV (EBS 1986B, p.51 and pp.58 & 59). This agrees well with the proportion including TV in their six choices for Question 20. The estimated number of classes seeing these science programmes in 1986 was about 10 000 (EBS 1986B, p.51 and p.58).

Use of film-strip projectors ranked comparably with the BBC micros. The survey of Autumn, 1985 showed that 66% of schools had a film-strip projector, but 40% of those who used slides as well found them more convenient, while 46% expressed no preference (EBS 1985A, p.4).

Radio was ranked in the six most preferred media by only about 5% of schools. Although the survey of Autumn 1982 showed that 97% of the schools possessed a radio, a typical school possessing 4 sets (EBS 1982/3A, p.4), the number of scientific educational broadcasts is very small. This may well be the determining factor and not popularity of such broadcasts with teachers. The listening figures for one such series, Secondary Science (14-16), were 6% in Spring,

1981 (EBS 1984/5A, p.69) and 3% in Spring, 1986 (EBS 1986A, p.72) representing an estimated audience of 1 820 and 620 classes respectively (EBS 1986A, p.72). It is seen that the (average) number of classes listening to a science programme is very roughly 10% of that viewing a science TV programme ('the average listening audiences [were] about 12% of average viewing for 1984-5' SYMONS 1987). 40% of schools listed TV programmes, and 5% radio programmes amongst their top six choices of a/v aid in response to Question 20 of the Directory Survey, which is compatible with the national figures.

With the advent of OVERTURE and its successor NERIS as modem-linked data-bases which teachers can consult for details of resource material, it is interesting to note that the 1986 survey (EBS 1986B) included a question about schools' possession of a modem and the system subscribed to. 27% of surveyed schools had a modem, with 15% subscribing to 'Prestel', 13% to the Times Network for Schools and 6% to other data-bases, often regionally organised by their LEAs (EBS 1986B, p.20).

It is interesting to note that 23% of schools in the Directory Survey listed audio cassette and (as mentioned above) 73% the slide projector amongst their first six most frequently used a/v aids. The EBS survey of 1982 identified that 99% of schools owned an audio recorder of some sort, though this included reel-to-reel recorders, and that 10 such machines were available on average (EBS 1982/3A, p.4). The 1986 EBS survey showed that 46% of surveyed schools possessed a slide projector used with a tape slide machine (EBS 1986A, p.26), and that in excess of 11% of science departments either owned such a machine or had regular access to one (EBS 1986A, p.28).

CHAPTER 8

SUMMARY AND ADVICE FOR PRODUCERS OF IPRM

Introduction

The following observations and recommendations are based on: two pieces of research carried out by the author (a pilot questionnaire, described in Chapter 5, and a postal survey (Directory Survey) monitoring a Resources Directory (BULLETT 1985), described in Chapter 6; two national surveys of teachers' use of IPRM (DICKER 1985) and of audio-visual aids in schools (EBS 1982-86) (outlined in Chapter 7); and a review of the literature concerning IPRM. Many of the successful strategies identified in the projects (summarised in Chapter 10) also merit attention by producers of IPRM when contemplating future initiatives.

The significance of the data

The pilot questionnaire was completed by some 25 science teachers at an annual meeting of the Association for Science Education. The Directory Survey was a postal survey of a limited, non-random sample of some 99 teachers. The small size of the sample in relation to the whole population means that one must be very cautious about extrapolating analyses and trends to all teachers of physics in secondary schools. Replies indicate that the teachers responding were typical of the whole population as regards the type of school in which they taught, but the representation of schools in the survey was less typical of schools in general, both as regards type and size; large (>1000) Comprehensive schools featuring rather prominently.

The national survey of teachers' use of IPRM (DICKER 1985) canvassed 7 500 secondary schools, and received replies

from 1 328, some 18% of the total, while the EBS surveys use stratified random samples of schools in the UK, to generate statistically significant responses.

Teachers' awareness of IPRM

There are strong indications that teachers are interested in using and value the provision of IPRM. As Donaldson has remarked: 'a further national input to education-industry liaison ... is a long tradition of companies providing resource materials for use in the classroom and ... there is every indication that teachers appreciate this facility' (DONALDSON 1982, p.8), and certainly the enthusiasm evinced by teachers in the possible production of a Physics Resources Directory at an ASE annual meeting would amply confirm this view. But it is also the fact that '... many schools are not aware of the existence of such valuable materials for subject teachers ...' (LEESON 1982).

The pilot study conducted at the ASE meeting (Chapter 5) posted a list of 48 companies producing materials thought to be relevant to physicists. Only 4 of the 25 teachers completing the questionnaire, presumably amongst the most committed, were able to add any further names to the list, although the Directory (BULLETT 1985) eventually included resources produced by some 46 companies, 16 of which were not included in the original list of 48.

Although only 6.2% of those responding to the Directory Survey indicated that they were aware of none of the resources included in the Directory, the maximum number which can be inferred as known to teachers before receiving the Directory is 20.7 per teacher, representing only 9.2% of the total items in the Directory, which were selected for their apparent relevance to the teaching of physics. The Directory persuaded teachers to order about 6 items on

average, though 27% ordered more than 7 items as a result of receiving it, further evidence that there was IPRM that teachers would have liked to use, but of which they were unaware. The message seems clear. A very small percentage of the total materials produced by companies are known to teachers of physics. Since the items in the Directory represented perhaps about 20% of the total items reviewed, physics teachers may only be aware of as little as 2% of the total production of IPRM, though this figure is based on the perhaps not unreasonable assumption that they are likely to be chiefly aware of resources relevant to their teaching specialism.

Recent recruits to the profession, with less than 2 years' teaching experience, seem more than usually unaware of the materials available. The average number of items of which they were already aware was less than half that of any other group of teachers, classified by teaching experience.

Teachers become aware of IPRM by a variety of methods. Question 13 of the Directory Survey and Question 6 of the National Survey monitored their relative importance.

By far the most common method was by post to schools, though reading journals came a close second, with an almost equal overall incidence. There were indications from the National Survey that postal advertising was not very effective, many teachers complaining that they were barraged with all kinds of "mail-shots", that much ended in the bin and that their access to material by this method was necessarily random.

The journals read most widely by teachers in the Directory Survey were the ASE's Education in Science and School Science Review, and the Times Educational Supplement. Each was the preferred reading of about one third of the

Directory Survey sample and read by more than 70% of the sample. Snippets, a magazine published by the Institute of Physics, was also read by about 70% of the Directory Survey sample, though was not preferred over the other three. Confirmation for the readership for the ASE journals was provided by the National Survey, though the percentage of the sample reading the TES as a source of information about IPRM was shown to be only half of that using the ASE journals.

Many teachers find out about and obtain materials by writing to companies, the third most popular means monitored by the Directory Survey. However, teachers experience considerable difficulties in doing so successfully, which is a pity, since this is a 'high motivation' method, and materials obtained in this way are perhaps more likely to be used. One of the problems encountered by the author was the difficulty in finding the correct address to which to send such enquiries. The response rate to the original request for information and materials for the Directory was only 60%, and no company, so far as could be identified, responded to an advertisement requesting information placed in Physics Bulletin. Some companies would seem not to be very active in bringing their materials to teachers' attention.

Teachers' use of IPRM

The Directory Survey showed that the average number of items used by teachers in the sample lay between 8.0 and 10.0, a maximum of 5% of the items in the Directory, which were selected as having potential relevance for teachers of physics. There was evidence that those teachers using IPRM were encouraged to order more by the Directory.

The pilot interviews (DICKER 1985) could find 'no example ... of a significant use of IPRM throughout the departments of science and mathematics' in the secondary schools in Surrey.

The National Survey and the Directory Survey both indicated that teachers prefer free resources and use IPRM mostly for passive, traditional activities in the classroom, with little project work, despite 65% of schools in the National Survey owning resource packs. 38% of schools used IPRM for laboratory work.

One of the most significant factors for a teacher is access to the necessary visual aids. Without this, various formats of IPRM cannot be used.

Teachers' use of a/v aids and resources

The two most popular visual aids are the VCR (VHS) and the OHP (used by 80% overall, and preferred by 32% and 30% respectively in the Directory Survey). 90% of schools in the EBS survey for 1986 possessed a VCR, with an average of 3.5 per school, with 29% of the sample having more than 4.

The slide-projector was used by 74% overall and was the first choice of 12% in the Directory Survey, and possessed by 80% of schools and more than 50% of science departments in the EBS surveys.

The BBC micro-computer was available to 66% of schools in the Directory Survey, with 38% having the B version and 28% the B version with disc drive. 98% of schools in the EBS survey had micro-computers, with an average of 14 per school from 1986, 30% of schools having more than 15. 92% had BBC A & B, 58% RML, with 33% using disc only and 66% using both disc and cassette. 41% of schools were intending

to standardise on 40-track drives and 19% on 80-track drives. In 42% of schools the micros were networked.

Television was possessed by more than 90% of the EBS sample, with roughly 30-40% of schools using the educational science programmes for the 11-16 age-range, which attracted average audiences of about 10 000 classes.

40% of the EBS sample schools used film-strip, though 40% preferred slides and 46% had no preference.

Audiences for educational science radio programmes were about 12% of those for similar television programmes.

27% of schools possessed a modem, according to the EBS survey in 1986, with 15% subscribing to Prestel and 13% to the Times School Network.

There is some indication that synchronised tape slide sequences would have useful uptake in schools.

Teachers' use of particular formats of materials in school were monitored by Question 21 of the Directory Survey and Question 1 of the National Survey.

Video cassettes (mostly recorded off-air, or borrowed free of charge), leaflets/booklets and posters/wall-charts were the most frequently used forms identified by the Directory Survey, with videos and booklets confirmed as the most frequently used form of IPRM by the National Survey. Computer programs were also popular, and although few examples of IPRM in this format were available at the time of the surveys (1985), there were indications that their use was growing.

Films (16mm), TV programmes and 35mm slides were used by

about 40% of the Directory Survey sample. It is interesting to note that the number of schools using 16mm films was roughly half the number using videos.

The National Survey found films, videos and computer software were popular with pupils in nearly all schools, while booklets were rated as popular by about two-thirds, slide/tape packs by half and wall-charts and activity packs by under half of the schools which used them.

Teachers' perceived needs concerning IPRM

76% of the National Survey sample felt that more IPRM should be introduced into their teaching, particularly to give applications of science, meet syllabus requirements, relate science to the outside world, and to provide up-to-date material at low or no cost. 21% of the sample felt that they already possessed enough IPRM, there was no time to use it in the curriculum and syllabuses did not warrant its use. This final view might well be less prevalent now that teachers are preparing pupils for the GCSE examinations which demand the inclusion of applications of scientific principles in courses.

The sample of teachers in the Directory Survey tended to obtain or use only some 50% of the limited examples of IPRM of which they were aware, so a substantial proportion of IPRM of apparent relevance would seem not to be meeting the needs of physics teachers.

The factors which determined whether they would select or reject IPRM were identified by the National Survey as: relevance to the curriculum, good visual presentation, low or no cost and suitability of language level.

The need for materials to relate to the curriculum is

supported by many of the directors of the selected projects (Chapters 9 and 10) and by the only report to deal at any length with the question of printed IPRM. 'The use of educational resources produced by industry and commerce is one very valuable way to ensure coverage by the curriculum of important aspects of modern industrial society. ... It is no good producing materials on banking, insurance, food, textiles, oil, chemicals etc. and making them available to schools without matching them carefully to curriculum needs ...' (LEESON 1982).

The factor of cost may not be as straightforward as the above may indicate. Although 77% of the materials ordered as a result of teachers receiving the Directory were free, compared with 56% in the Directory as a whole, the National Survey indicated that 50% were able to pay less than £5 for a resources pack, while 24% could afford up to £20. There was also evidence that a number of teachers pay for some IPRM out of their own pockets.

In response to a question asking their opinion about how IPRM could be improved, teachers suggested using teachers in its preparation, in addition to ensuring it matched more closely the desired characteristics and purposes for which they wished to use it, outlined above.

Advice to producers of IPRM and some possible strategies

As indicated above, teachers value IPRM but are unaware of a considerable proportion of materials which would be relevant to their teaching. Possible ways to improve their awareness by advertising by post might include:

addressing information to a named individual, or
at least the relevant teacher responsible (for
example, Head of Physics)

including sample pages of the material, or a clear description of what it consists, and for whom it is intended

including a simple, reply-paid order-form

stating if the material is available for review at a local teachers' or resources centre

making it clear how the material relates to curricula or syllabuses (if it does)

keeping a data-base of teachers (and schools) ordering IPRM, so mailing can be personal and selective.

Other strategies for bringing IPRM to teachers' attention, might include advertising in Education in Science, School Science Review, Snippets or the TES (in the last three, submitting IPRM for review) and taking a stand at the Annual Meeting of the Association for Science Education, perhaps sponsoring a workshop in the use and adaptation of the company's IPRM.

There would seem to be a considerable advantage in making sure that training colleges and university departments of education are well-informed about what IPRM is available and encouraging them to establish libraries of materials to allow students to familiarise themselves with IPRM and to try them out during teaching-practice. There is also the opportunity for companies to sponsor an exercise in the adaptation and use of industrial materials during students' teaching-practice. An advantage here is the potentially positive influence on teachers in the teaching-practice school. An example of this approach is described in Chapter

11.

Many teachers write in to companies with requests for IPRM to help them with particular aspects of their teaching (ICI alone receiving some 5 000 letters per year from this source (ICI 1981)) but this can be a frustrating process, as the author discovered when assembling materials for the Resources Directory (1985). Those responsible for the production of IPRM within a company should try to ensure that:

teachers are informed clearly about where they should write for IPRM

the source of IPRM is well known to all employees, particularly when the company has many divisions, and that the materials themselves are familiar to fellow employees

staff dealing with requests have the skill and experience to match the IPRM to the needs of the individual enquirer

catalogues identify the subject areas and age-ranges for which a particular item of IPRM is suitable

enquirers are referred elsewhere if the company concerned is unable to help by providing relevant IPRM, and that a "standard package" is not sent automatically.

Most science teachers will now have ready access to a VCR, and the VHS format for videos is used in nearly all schools. Free-loan is likely to encourage teachers to obtain the videos, while even a nominal hire-charge may

deter them. 16mm film is likely to be regarded as less convenient than video in at least 50% of secondary schools. Slide projectors are available in about three quarters of schools, but their use is not nearly so popular as video.

The school standard is the BBC-B micro-computer, with disc drive, 40-track drives being twice as prevalent as 80-track. Nearly two thirds have RML machines. 42% of schools have multiple micros which are networked. The use of computer software is popular, and IPRM in this format to add to the small amount already produced, would be well received.

Only 40% of schools use film-strip, though 40% preferred slides.

A typical television educational science broadcast is viewed by about 10 000 classes and this represents a considerable and accessible population which producers of IPRM might well try to reach by suitable negotiation with the television companies. They could sponsor programmes, for the independent companies, and make their plant available to producers of programmes for all channels for filming applications of science or industrial processes.

The research indicates that there is scope for the medium of synchronised tape/side sequences to be exploited more widely by producers of IPRM. The cost of production compared with video cassettes should enable them to be provided more cheaply, though their convenience for the teacher (two machines are required) and their motivation for pupils may not be so great.

The Directory Survey showed that collecting details of material together in a directory has the potential to increase teachers' uptake of IPRM, in some cases nearly

doubling it. Ideally, material should have some sort of evaluation by teachers. Ready updating and accessibility makes it desirable to take advantage of the electronic communications systems coming on stream for such a collection.

With the advent of modem-linked database systems, such as NERIS (described in Chapter 9), producers of IPRM have the means to advertise their materials to teachers, include reviews, samples or entire texts for downloading, and if the systems are interactive, to allow immediate ordering of the IPRM. Databases of industrial information are already supplied on disc by some organizations, and the development of the CD-ROM should greatly extend the potential of such databases. There is also the possibility of combining the new technology with a consultancy service, a prototype for which is running at present and which is reviewed in Chapter 11.

These suggestions have been made to improve the dissemination of the materials traditionally produced as IPRM. The single most important requirement of teachers is that IPRM should be relevant to the established curriculum, and few existing resources are easily related to curricula or syllabuses. As is seen in the next section, many of the most successful initiatives in the area of school/industry materials (IRM) have depended on collaboration between industry and teachers in joint projects. The author would commend this pattern to industrial and commercial companies. Although it is expensive, it has proved effective in meeting many of the objectives which industry has for school/industry liaison, as well as providing much needed resources for teachers to meet the demands of the new GCSE examination syllabuses for applications of science.

Effective evaluation of IPRM must also play an important part in informing producers of their usefulness in school and their role in influencing the attitudes of teachers and pupils towards industry. Chapters 11 and 12 outline some possible evaluation strategies which the producers of IPRM might find helpful, and Section 5 of Chapter 4 (above) discusses some research which suggests that specifically designed IPRM can influence student attitudes successfully.

A paragraph in a study of industry and Scottish schools, highlights the major concerns of this chapter. 'Too often, industrial concerns, including companies, can produce materials which do not relate to Scottish curricular objectives, are difficult to use in a classroom or are too heavily influenced by marketing considerations. The preparation of materials for use in a classroom would seem to be a key area in which industrial and educational expertise could work jointly to produce relevant and up-to-date resources which can be taught in schools as they function at present. The business of curriculum development is a highly complex one involving both philosophical and practical issues, and credibility in this area demands a systematic and professional approach by all concerned. Initiatives in this field must be well planned, balanced and properly executed if they are to achieve their desired effects.' (DONALDSON 1982, p.13.)

CHAPTER 9

SIX PROJECTS WHICH GENERATED OR FACILITATED
INDUSTRIAL RESOURCE MATERIALIntroduction

As described in Chapter 4, the ten-year period following the Ruskin College speech was one in which the mutual influences of industry and education were brought firmly into the domain of public debate. Much effort went into establishing school/industry activities, but as important as they were, these initiatives were predominantly locally-based and inevitably operated more effectively in some areas than in others. Projects which attempted to raise pupils' and teachers' awareness of industry by the generation of written materials, bringing applications of science from the industrial context into school, were very much in a minority. However, because they were nationally-based, they individually had the potential to influence a much larger number of schools and pupils.

There was only a handful of such projects relevant to the teaching of physics (or science) whose products had found their way into many schools and which were widely regarded as successful by teachers. It seemed important to examine their strategies and structures to see what allowed them to become successful producers of materials, how their products were brought to the attention of teachers and how teachers were intended to use what they generated. In particular, there was a desire to get behind the formal, published accounts of the projects.

Although a large proportion of the projects received industrial funding, only the first group was sponsored directly by educational sections of industrial companies.

It was hoped that having identified teachers' perceived needs through the questionnaire survey, a study of "good practice" in the field could provide information for industrial companies about how their resources might be used most effectively, the factors likely to improve the relevance and uptake of the materials they produce, and perhaps to point towards successful strategies for involving teachers more closely in their generation.

A successful research strategy would have to provide a detailed knowledge of those facets of the projects which enabled the successful production of materials and their wide dissemination in schools; ideally, providing an almost vicarious experience of those aspects of the projects. These considerations pointed to case study as a promising approach.

A summary and discussion of the insights which emerged from the present study of the projects is undertaken in Chapter 10, to which readers not requiring details of either the research methodology employed or of the six individual projects, should proceed directly.

CASE STUDY AS AN APPROACH TO RESEARCH

Over the past twenty years or so, a somewhat controversial tradition of educational research termed "case study" has emerged, which has been characterised as historical, interpretive and subjective, in contrast to experimental research, whose context is to be found within the hypothetico-deductive tradition of natural science. An early attempt to establish the characteristics of case study took place at a conference held in Cambridge in 1977 (reported in ADELMAN, JENKINS & KEMMIS 1977), and though there has been detailed work since into the philosophy

(KENNY & GROTELUESCHEN 1984) and epistemology (LAKOMSKI 1987) of case study as a research technique, the conference report deals with practical considerations, and attempts to 'demystify case study methods by articulating as clearly as possible how the work is planned and carried out' (ADELMAN et al. 1977, p.139). Their analysis underpins this section.

Definition

Case study may be defined as 'an umbrella term for a family of research methods having in common the decision to focus an enquiry around an instance' or, more concisely, as 'the study of an instance in action'. It is not the name for a standard methodological package, its 'methodology is eclectic, techniques in common use including observation (participant and non-participant), interview (conducted with varying degrees of structure), audio-visual recording, document collecting and the negotiation of products' (ADELMAN et al. 1977 p.141). It is often regarded as complementary to the systematic techniques of the survey, which, although possessing well-tested procedures, 'may obliterate ... unique features and patterns' and where 'the researcher finds out only what he seeks' (NISBET & WATT 1980, p.8).

Strategies

Case study research is typically set up in one of two ways:

1. an issue or hypothesis is given, and a bounded system (the case) is selected as an instance drawn from a class;
2. a bounded system (the case) is given, within which issues are indicated, discovered or studied so that a tolerably full understanding of the case

is possible.

(Source, ADELMAN et al. 1977. p.141.)

In the first, the instance may be chosen as having a prima facie representativeness and the study will be predisposed towards making generalisations about the class, though the description of the case as the study proceeds will increasingly emphasise its uniqueness. In the second, the study will be predisposed towards making generalisations about the case, which in turn promotes generalisation from case to case. In practice, the two "ways" refer more to the purposes behind the research than to distinct approaches, and every case is 'profoundly embedded in its real world situation' (ADELMAN et al. p.142).

Generalisations and their validity

The generalisations produced by case study are neither stronger nor weaker than those of experimental research; they are different. Experimental research guarantees the veracity of its generalisations by reference to formal theories, the truths contained in a successful case study report are guaranteed by 'the shock of recognition' in the reader. Stake has classified the former "formalistic" and the latter "naturalistic" generalisations (see STAKE 1975).

Three kinds of naturalistic generalisation are possible from case study:

1. generalisation from the case (instance) studied to the class it purports to represent;
2. generalisation from the case-bound features of the instance to a multiplicity of classes;

3. generalisation about the case (instance) itself.

The first strategy outlined above will tend to lead to either the first or second class of generalisation. Some of 'a multiplicity of classes' may point in unexpected directions and so broaden the scope of the study. The second strategy outlined above will be predisposed to making the third sort of generalisation. In its most significant form, this can promote generalisation from case to case; teaching by example rather than precept.

An important process in establishing the validity of the observations of a case study is their internal consistency. "Triangulation" is the process by which one source of information is checked against another, and observations in one context are checked against others in comparable situations. Data is checked across a variety of sources and a variety of methods. (Source, NISBET & WATT 1982). In presenting the findings of the study, the reader should be allowed to reconsider for himself the relation between assertion and evidence: the raw data needs to be available as well as the interpretation. This procedure has the additional merit of enabling the reader to use the cases presented to inform different concerns.

Undertaking case study

'Decisions about how case studies should be planned, conducted and reported are as much practical decisions as theoretical, governed by the exigencies of the situation, as well as by general views of educational research and evaluation' (ADELMAN et al. 1977, p.140), and perhaps for these reasons, 'nobody is too sure how case study workers should be trained' (op. cit. p.146). However, some of the considerations which arise in planning a case study may be

gathered under the following heads: the circumstances of the case, the conduct of the study and the consequences of the research.

The circumstances of the case. Case studies are carried out in real situations in which the people studied and the researcher have responsibilities and obligations. A "research contract" is an explicit way of safe-guarding the interests of both parties.

The conduct of the study. Often an open phase characterises the beginnings of case study, particularly if the second strategy outlined above is adopted. Eventually, however, a focus to the study will be needed. This may be the formulation of a hypothesis, or the articulation of a particular area of concern, and will be followed by devising a way to gather and record data concisely, lucidly and as impartially as possible. The data and observations are then drafted into a preliminary report, which contains any hypotheses, deductions, generalisations or interpretations by the researcher. This is then usually referred to those observed for checking, comment or emendation, according to the research contract. (For a detailed consideration of the checking of interviews by the interviewee, see YEOMANS 1987.) The report is then put into its final form.

Consequences of the research. The confidentiality of the material elicited has ethical implications for the researcher, particularly when he considers publication. Anonymisation of the report is rarely a satisfactory solution, unless the only objective is to make generalisations to the class from which

the instance is drawn, and the readership is limited to those outside the study. Otherwise, anonymisation prevents the case study's feeding reflection and action within the situation itself. A better approach is a research contract, which identifies the forum of publication and likely readership in advance and gives those concerned negotiated rights over the material gathered.

Despite the difficulties associated with case study, it has peculiar strengths, summarised in a chapter on case study in Research Methods in Education (COHEN & MANION 1985, p.146). Those relevant to the present study are outlined below.

1. Case study data is strong in reality and can thus provide a 'natural' basis for generalisation.
2. Case studies' peculiar strength lies in their attention to the subtlety and complexity of the case in its own right.
3. Case studies, considered as products, may form an archive of descriptive material sufficiently rich to admit subsequent reinterpretation.
4. Case studies are a 'step to action'. Their insights may be directly interpreted and put to use.
5. Case studies present research in a more publicly accessible form than other kinds of research report, and can serve multiple audiences. At their best, they allow the reader to judge the implications of a study for himself.

METHODOLOGY FOR THE STUDY OF THE PROJECTS

Selection of the projects

Many examples, perhaps the majority, of traditional case studies take single instances for in-depth analysis, often employing participant observation as the chief agency of data collection, and using the study for illuminative evaluation of the case in question. A minority takes a handful of instances of a particular class, and attempts generalisations about the class from their findings. A large-scale example of such a study was carried out by Lambert, Bullock and Millham in 66 boarding schools, though they also had an "intensive sample" of seven schools, which is more relevant to the present case. (For a summary of their methodology, see COHEN & MANION 1985, p.133.)

To paraphrase the introductory letter to project directors (reproduced in full in Appendix C.1), the objectives of the present study were to concentrate on the stimuli and motivation behind the projects, the experiences of establishing and evaluating the projects, how these might develop in the future and how the continuing need to give teachers and pupils access to appropriate material could best be met in the longer term. There was no intention to attempt an "evaluation" in the traditional sense, either of the projects or the materials they generated, though one (SATIS) had begun an evaluation and there would clearly be scope for evaluations of other projects' products, perhaps using the model outlined in Chapter 12 of the present thesis. Instead, an approach was needed which gathered information to enable the particular focus outlined above. In the event, a modified form of the first strategy for case study identified in the previous section was adopted. Six projects, or groups of projects, were selected with

prima facie representative of a class which made available applications from an industrial context to teachers and pupils in school; indeed they virtually constituted the class. The means by which they made the applications available were, however, very different. In order to allow generalisation about the class (the elements the projects had in common) and also generalisation about the instance (how the particular contribution each was making in the field might be developed and extended), it was necessary to strike a balance between an exhaustive analysis of a single case and only reporting those elements the projects had in common. The hybrid methodology which emerged to achieve this balance and achieve the desired focus is outlined in the next section.

The choice of methodology

A "practical" decision was made to concentrate the study on a project's director or editor. Not only were they uniquely placed to provide the material to achieve the focus outlined above (indeed, it is doubtful if any other individual or group of individuals associated with a project could provide such material), but few of the projects were located within one institution (with the possibility of observable interactions), most of the contributors to the projects were geographically dispersed, some of the projects were completed and their infra-structure dissolved, and much of the evolution of a project had occurred through a myriad of interpersonal exchanges, rather than formal meetings, scarcely any of which were minuted. By focusing on those individuals responsible for establishing and directing the projects, one also had the opportunity to gather opinions about general issues from those who, by their experience and involvement in the field, could reasonably be expected to have some relevant insights to share.

The interview

An interview has been defined as 'a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focused by him on content specified by research objectives of systematic description, prediction, or explanation' (COHEN & MANION 1985, p.291). (An overview of the extensive theoretical developments in this field is provided in COHEN & MANION 1985, Chapter 13 and WRAGG 1978.) It has been observed that 'the direct interaction of the interview is the source of both its advantages and disadvantages' (COHEN & MANION 1985, p.292): an advantage being that it allows for greater depth than other methods of data collection, a disadvantage being the risk of subjectivity and bias on the part of the interviewer. The latter can be ameliorated to a certain extent by presenting the data and generalisations separately, and allowing the reader to judge for himself, though the conduct of the interview is bound to depend heavily on the interviewer.

The various strategies available for interview may be grouped broadly into structured, unstructured, non-directive and focused. The focused interview differs from other types of research interview in certain respects, which may be summarised as follows:

1. The persons interviewed are known to have been involved in a particular situation.
2. By means of content analysis, elements in the situation which the researcher deems significant have been analysed by him.
3. Using his analysis as a basis, the investigator

constructs an interview guide. This identifies the major areas of enquiry and the hypotheses which determine the the relevant data to be obtained in interview.

4. The interview focuses on the subjective experiences of the persons. Their responses enable the researcher: (a) to test the validity of his hypotheses; and (b) to ascertain unanticipated responses to the situation, thus giving further hypotheses.

The technique employed in the present study was a semi-structured, focused interview.

Validity

There are clearly implications in such an approach for the degree of internal and external validity which the case study can achieve. The method of "triangulation" described above was applied during and after each interview. Published accounts of the projects (official and critical), the materials, reviews of the materials and the reaction of other project directors to the projects and stated opinions, all informed the internal validity. The external validity relies in the final analysis on the extent to which the reader is convinced by the reports of the interviews and the generalisations about them and from them. The method of presentation adopted, accounts of the projects and the interviews later in this chapter and the summary and conclusions in Chapter 10, hopefully allows the reader to assess these matters for himself.

Organization of the case studies

The case-study interviews with those responsible for directing or co-ordinating the projects were conducted during the six month period from January to June, 1987. The procedure adopted for all the studies was as follows:

1) A letter was written to the target interviewee which outlined the intended scope of the research and elements of the research contract, and invited him to complete a short questionnaire. (Examples of each are reproduced in Appendices C.1 and C.2.) The questionnaire was to establish the chronology of the project, obtain references to published accounts of the project and its development (if any), and to establish possible times and a venue for the interview.

2) Having digested the references and obtained copies of the project materials or accessed the data-base, a summary was sent to the interviewee which represented the author's understanding of the factual background to the project concerned, together with an interview schedule which outlined general areas to be explored (see Appendix C.3). The purpose of the former was to indicate what could be taken as common ground in the interview, to save time, whilst the schedule served a dual purpose: to allow any necessary research, gathering of figures, collecting of thoughts etc. to take place prior to the interview and to ensure that a nucleus of questions was common to all case-studies, to enable generalisation and inter-study analysis.

3) A semi-structured, focused, recorded interview

was conducted, lasting about an hour, when the questions in the interview "schedule" (Appendix C.3) were put to the interviewee and any matters arising explored. The tone of the interview was kept informal, and the "schedule" used only as a guide, since the projects differed considerably in their approach and it was important to encourage the interviewee to be discursive. The opportunity was also taken to put some of the tentative conclusions of the research and views expressed by project directors in earlier interviews for comment.

4) The content of the interview tape was edited and transcribed, and combined with the factual summary, outlined in 2 above, to produce an account of the project and to represent the views and opinions of the director interviewed. As this was then sent for emendation, amplification and comment, the accounts of the projects have some claim to both accuracy and authority.

THE PROJECTS

PROJECT 1: 'Physics at Work'
 'The GASS Book'
 'TIP'
 (Telecommunications in Practice)

A summary of the projects and an interview with Brian Nicholl and Jenny Selfe (Partners, NS Educational Consultants) on Monday, 30th March, 1987 at their offices at 5 Dryden Street, Covent Garden, London.

The structure and organization of each initiative is sufficiently similar to allow a common outline description and they were treated together in the case-study interview.

Each represents a partnership between a major industrial company and a professional organization (the Association for Science Education), each introduced practising teachers into an industrial environment to produce materials designed to illustrate applications of science within industry which were subsequently published by the industrial concern jointly with the ASE, each was launched at an annual meeting of the ASE and all three had the same educational consultant, Brian Nicholl.

An electrical engineer by training, his interest in science applications dates back to the mid-fifties when he was Head of Science in the first of the Technical Secondary Schools in Birmingham, in some ways the successors to the Junior Technical Schools. Here the aim was not to teach technology per se, but to devise 'O' and 'A' level courses for future engineers in physics, chemistry and biology, rich in industrial applications for which funds had been specifically allocated. He was national co-ordinator for the Young Engineer for Britain Competition and had organized a project in 1979 for the ASE (funded by the Department of Industry) to produce the ASMIT (Applications of Science and Mathematics to Industry and Technology) materials. The ASMIT initiative was a direct consequence of the report by a joint committee of the Council of Engineering Institutions and the Royal Society.

About the time Brian Nicholl became a free-lance educational consultant, he was approached by BP to co-ordinate what emerged as the 'Physics at Work' project, which formed an educational component to the Faraday Lecture which they were sponsoring that year (1980).

A detailed account of the background to the 'Physics at Work' project is given in A Guide to a Schools/Industry Project (PHYSICS AT WORK 1980B) and although this was the earliest of the three projects, the methodology evolved only slightly, the most significant change being the increase in the time teachers spent "on site": two days for 'Physics at Work' to two two-day visits, two months apart, for the 'GASS book' and 'TIP'. The Guide represents an admirable aid for any group considering combining with industry to produce educational materials. Some details of the organization of the other two projects are given in the introductions to the published materials they generated. See Gas Applications for School Science: Resource Materials for Teachers (GASS 1982) and Telecommunications in Practice: Resources for Science Teaching (TIP 1985).

The three projects were sponsored by British Petroleum (to reinforce and complement the information delivered in the Faraday Lecture, 'The Electronic Oilman'), British Gas and British Telecom respectively and were launched at the ASE annual meetings in Hull (1980), Warwick (1981) and Exeter (1984). The project teams consisted of a representative of the sponsoring industry's education service, Richard Turner (an Assistant Secretary of the ASE), Brian Nicholl (Education Consultant) and John Nellist (General Adviser/Inspector, Cumbria).

The much-quoted speech by the then Prime Minister, James Callaghan at Ruskin College, Oxford in October, 1976 may be regarded as bringing many of the issues which had long been current in educational circles into the public domain. In 1980, the Finniston Report (FINNISTON 1980) stated that 'instilling an appreciation and understanding of industry and technology is a highly desirable, if not essential, requirement of the school curriculum for all children and a

full understanding of this should be possessed by teachers'. It was against this background of an articulated and vigorous public debate, that British Gas launched its GASS project in the same year that its chairman, Sir Denis Rooke, took the presidency of the ASE.

It is interesting to note in the light of the quotation from the Finniston Report, that although written materials are the tangible product of all three of the initiatives, both the stated objectives and the opinions of those involved indicate that they were an important but secondary outcome; the 'process', giving teachers a first-hand, motivating and enriching experience of industry and similarly, giving researchers in industry an educational perspective of their work, being the principle objective. Indeed, the view of two members of the project teams is that if one wanted just to produce material, then the model adopted would not be the most efficient or cheapest way of doing so. In later projects, for example Experimenting with Industry (SCSST/ASE 1985), written materials were the primary objective. Teachers were asked to write to a specific brief: to produce material for practical work in the laboratory in the form of Teacher's Guide and Students' Notes.

Each of the three projects formally articulated their objectives, and although these differ somewhat in detail, they may essentially be summarised under the following heads:

to provide the opportunity for teachers to become acquainted with the technological activities of a major industry,

to encourage the participants to investigate how particular industrial applications could be

related to the content of modern science teaching syllabuses and to the intellectual maturity and interests of the students,

to help students gain a better appreciation of the role of science-based industry within the community,

to enable the participants to produce teaching materials related to the applications investigated at the site visited,

to publish the collected materials in a form that would enhance the teaching of science far beyond the immediate sphere of influence of the individual participants,

to stimulate the participants to set up links with their own local industries.

In several cases this latter objective was reported as having been achieved, and interestingly, a number of the participants subsequently became involved in national developments, such as the Secondary Science Curriculum Review or became Science Advisers, so their perspective was eventually communicated to a wider audience. The Editors feel that there was some need for a package which helped industry and teachers get together on a local basis to produce materials and communicate effectively with each other. To some extent, the Guide to a School/Industry Project (PHYSICS AT WORK 1980B) fulfils this role for a national project, whilst the 'Industry Year' materials and documents produced by SATROs make suggestions for local links.

The teachers for all three projects were recruited and

selected by the ASE. The selection criteria for the 'Physics at Work' project included: 1) a member of the ASE, 2) an experienced Physics teacher, 3) teaching in a UK school, 4) participation supported by head teacher, 5) able to take time off school and 6) some indication that they were willing to write educational material. For the 'GASS' project, applicants were asked to give information about 1) the subject they taught, 2) any industrial experience, 3) papers published or contributions to curriculum development and 4) the kind of material they would hope to contribute if selected, and were also given brief descriptions of topics likely to be relevant to each site and asked to make a first and second choice.

It is interesting to note that the impression of the co-ordinators is that the number of teachers with previous experience of industry grew very considerably from the 'Physics at Work' project (1980) to the TIP project (1985). It would be interesting to examine the selection procedures in some detail, though of course the selection could only be made from those teachers who applied; the accepted wisdom is that teachers have been moving from teaching into industry in increasing numbers during this decade and not vice-versa. The industrial background of many of the participants was an advantage since they were often dealing with highly technical material; indeed, one group attached to a research station had all pursued research to a high level.

In all cases, some members of the project team and the education consultant made preliminary visits to the sites to:

investigate the feasibility of teacher attachment
at a busy complex,

brief site personnel on the aims and intentions of the project.

formulate a broad outline programme for each visit.

and identify technical areas of activity in which the broad aims of the project could be achieved by the teachers.

All the literature indicates that with backing at the highest level (in the case of two of the projects, the Chairman of the company lent his personal support), the industrial contacts were very co-operative, but the project team had to work hard initially to communicate the objectives to the company personnel and convince them of its value; after all, they were being deprived of four days' working time. However, many valued the opportunity to talk to someone in the same discipline, but with a different perspective, and thought it would help them to understand the educational background of recent graduates coming into the research environment. Commercial security was an aspect which had to be respected, but given the proviso that the organization had the power of veto as regards publication, it presented few difficulties in practice, even when teachers were attached to high technology research stations. There are indications that with privatisation, companies may be rather more sensitive about commercially valuable information. All teachers were briefed in advance that they might be refused certain information on commercial grounds, and this contrasting aspect of industry compared with education helped to develop teachers' perspective of it.

A visit co-ordinator was appointed at each site to liaise with the project team and individual teachers and to

organize details of the visit.

For the 'Physics at Work' project, teachers received a detailed brief from the consultant about areas of possible writing. Visits to the sites by teachers occupied two days, the one-to-one link between them and researchers often continuing after the visits, for clarification of specific matters and the acquisition of additional information. In the 'GASS' and 'TIP' projects, a preliminary two-day attachment in the Summer Term provided the opportunity to become familiar with an area of interest identified by the consultant and to gather the information needed to start writing. June and July were used for consolidation, and a second two-day attachment was used to complete the fact-finding, check information for accuracy and refine the draft material.

All three projects actively involved teachers in the production of materials. This was an established policy with, for instance, British Gas, but industrialists have traditionally found working with teachers rather difficult, because they are working in their own time and the imposition of dead-lines, required by industries' budget years etc., has not been easy. The projects made time for teachers to be involved by making requests for time away from school for the initial visit, and on a quid pro quo basis asked teachers to give up a small part of their holiday for the follow-up visit. This more formal structure seemed to have many advantages for both sides, and perhaps points towards day-release or secondment for fruitful involvement of teachers with industry.

The incentive for teacher involvement in the three projects was that it provided an in-service opportunity, but in some recent development, e.g. 'Experimenting with Industry', teachers received an honorarium and this is increasingly

the practice. The General Editors did not detect any difference in attitude among participating teachers, but wondered if in the current climate, they would have found it as easy to recruit teachers for involvement in the GASS project for instance.

Teachers were given considerable flexibility as regards the format in which the materials were to be produced. They generated material relevant to their own experience, expertise and local circumstances, determining for themselves the content, style of presentation and the age and ability range of the target pupils, though in the GASS project they were encouraged to produce material for the early years of Secondary schooling. Some chose to write resource material for other teachers, some background reading for students and others lesson plans and work-cards. In all three projects, the nature and intended use of the item was stated clearly on the title-page.

Teachers also took responsibility for assessing the target age-range and ability-level for the materials, and the trials of the material in their schools during the period between attachments to industry doubtless informed their assessment. In the first two projects (PHYSICS AT WORK 1980 and GASS 1982) these were indicated roughly by 'upper school' and 'lower school' identifiers, with an occasional reference to 'O' or 'A' level, but in the TIP 1985 project specific teachers' guidance to intended age and ability level is given on the title page. The General Editors expressed reservations about specifying age-range and ability-level for material in general because of the inevitable differences between pupils and schools. The strategy they adopted in later projects, for example the British Gas primary science pack 'Science Scene Setters', was to give a general indication, but stress that the teacher using the materials would best know what would suit

his or her pupils.

All materials were published, some for the 'Physics at Work' project appearing as ASMIT cards (ASMIT 1981). Apart from editing for consistency of style and in the use of units (though in industry pressures are measured in psi and temperatures in Fahrenheit, and to reflect this situation, the appropriate units for particular applications were used), the project organizer had to bring all the contributions to a standard where they could be published. A small number of items were reduced in length or the style of presentation changed. In about 50% of cases this demanded extensive editing, amounting to re-writing, and the editors feel that this is perhaps because teachers are primarily oral communicators to a specific audience, their class, and they are not used to communicating with a third party, another teacher, in writing. This sometimes resulted in the material being presented in a personal and non-transferable way. The immediate feed-back of pupils' questions on what teachers present in class may encourage them to adopt an "ad hoc" approach and this may be reflected in the apparent lack of a logical structure in some of the submitted items.

In none of the three projects were the issues of ethnic, cultural and gender bias considered specifically, mainly because of the "objective" nature of the material and also because the issues had not become so contentious as at present. However, in the later primary science project, a balance was specifically struck to represent women and minority groups in the materials.

The time-scale for the production of the camera-ready copy for publication was short: ten months from conception to completion in the case of the 'Physics at Work' project. This ensured that 'materials meet the need to provide

up-to-date examples of how knowledge is applied in industry' (TIP 1985).

As they were joint publications, the ASE heavily influenced the format of the materials for all three projects, a major consideration being cost. The result was copy-right free, photocopyable, A4 masters (punched for a ring binder), with a two-column design for 'Physics at Work', but three columns for the latter projects. The design became progressively "cleaner" and more open, with a larger print-size and the introduction of a second colour in the TIP publication. The two column text ensures a shortish line length and the three column grid allows illustrations to be one, two or three columns wide. Apparatus lists and teachers' notes can be accommodated easily in the margins. The General Editors pointed out that commercial publishing houses are not usually able to justify so much empty space on the page on commercial grounds.

The economics of photocopying from masters is complex. It is certainly possible to produce printed multiple copies at lower unit cost, but there is some evidence that teachers are able to photocopy more freely in school, with the cost sometimes not having to be met from the departmental budget, while raising an official order is time-consuming, eats into capitation, and has to be done long in advance of each occasion they wish to use a new item. A collection of masters also ensures that all the material is immediately available in the school.

A direct consequence of the photocopyable master is that the copies produced have been criticised as appearing 'dull and uninspiring' in some quarters. The General Editors are now moving to the view that if a project is to excite and enthuse children about industry, it needs visual impact, which black and white line-diagrams are not easily

able to create. The naturalness of colour prints demands a greater financial commitment on the part of industry if the materials are not to be more expensive for teachers, but if the materials are used and achieve their objectives more effectively, industry seems generally willing to bear the greater cost. Of course, the problem for teachers in ordering multiple copies remains and teachers tend to be suspicious of glossy material which they can perceive as being promotional or even propagandist. The design of materials was usually undertaken by the design or publishing section of the industry concerned, though the editors retained control and had sometimes to restrain the creative flair of the design team to ensure that the materials did not create this unfavourable impression with teachers! The unit cost of high quality, colour material is often lower than teachers appreciate, especially if printed in large quantities, and colour allows greater density of information and impact. Perhaps the ultimate in colour presentation is the video cassette, which together with computer software is being taken up by a number of companies.

Evaluation of the materials in all the projects was carried out by teachers with their own pupils, though in the case of GASS, evaluation forms were sent to all teachers who had participated in the project asking them which materials they had subsequently used with their pupils. The results were not encouraging as few had used any materials other than their own, and some had not even used those. A recent initiative of work-shops for teachers has been established with British Telecom, based on the Experimenting with Industry (SCSST/ASE 1985) materials on optical fibres. This was in a direct response to the perception that although there is a high level of awareness by teachers of the materials available, they do not necessarily use them. The General Editors are aware that teachers are reluctant to

use material, even if written by a teacher, without having the opportunity to try it out for themselves. The advantage of a work-shop environment is that it makes time for teachers to experiment, with technical support readily available, and industry is becoming more interested in the process of dissemination as the logical follow-up to origination.

The General Editors are also conscious that the material produced as a result of the three projects is not explicitly related to syllabuses and that teachers have to make the match themselves. With some 15% of assessment within current GCSE science syllabuses being related to applications, teachers may find the necessary stimulus to use the resource materials they already know to be available. There is some anecdotal support for this contention in the vastly increased demand for places at recent 'Physics at Work' exhibitions sponsored by the Institute of Physics.

In general, the Editors felt that for material to be readily used it had to be "teacher-friendly", more closely targeted, high-profile, directly related to individual subjects and syllabuses, and of high quality but low cost. Many existing materials are flexible, but require time and effort on the part of teachers to adapt them to their individual needs. This may have deterred teachers from using them.

PROJECT 2: OVERTURE

A summary of the project and an interview with Dr RW Buckley. Joint Chairman of the Physics Subject Panel, at Twyford Church of England High School, Acton, London on Tuesday 31st March, 1987.

The joint chairman of the physics subject panel was invited to join the project by the Director, on the recommendation of a colleague at Southampton University. While Deputy Head of a school in Humberside he had been involved in project work in the area of solar energy conversion for the Solar Energy Trust. His school was twinned via the local SATRO (The Humberside Forum) with British Aerospace, the major local employer, which allowed a joint management training programme and co-ordination of computer education and administration.

The chairman identified several factors which prompted his involvement in OVERTURE and his commitment to its objectives. The DTI survey prior to the inception of the Study identified that something less than 2% of examination questions at 16+ had anything to do with applications and industry. Also, the debate which foreshadowed the evolution of examinations to what eventually became GCSE meant that examinations would inevitably be more student-centred, more project and course-work orientated and this would create a demand for resources. It was widely felt that if science teaching was applications-based, it would be more attractive to pupils at a time when there was an acute national shortage of trained engineers and qualified science teachers. That science teachers seemed almost a dying breed was reflected in the fact that the chairman's involvement in various projects brought him into contact with the same ten or fifteen teachers who were keeping the initiatives going.

OVERTURE was set up by the Industry/Education Unit of the Department of Trade and Industry in partnership with the Southern Science and Technology Forum in January, 1984. As its name implies, the intention was that it should be a pilot study and precursor to a permanently established

national database, freely accessible by schools via a telephone link modem. OVERTURE formally ended in December, 1986, and it was succeeded by NERIS (National Education Resources Information Service), whose scope extends beyond the science and mathematics focus of OVERTURE.

Detailed accounts of Overture's inception, progress and concluding recommendations for NERIS may be found in three reports and a resources package (OVERTURE 1985, 1986A, 1986B and 1986C), and a technical appraisal and costing of possible database systems in Bevan 1984, but it is relevant to the present study to highlight certain cardinal features of the initiative.

In summary, the objectives of the project were to provide on a database, information and everyday applications related to specific topics in mathematics and the school sciences to bring home to young people of all abilities an appreciation of these applications and an awareness of the place of industry in the community. Teachers are known to be bombarded with material in school, and inevitably a lot is consigned to the bin. The attraction of a database was that it represented a new approach, with new technology to which most schools had access, and provided an instant resource to allow a more relevant, applications approach and perhaps to stimulate new ways of presenting traditional topics.

The intention was to produce "lesson-ready" material as far as possible, to help the largest number of teachers take an applications approach. OVERTURE was trialled at a time of considerable unrest within the profession, and given the constraints of time under which teachers usually work, the material had to be "instant". In the short-term, little time was spent cataloguing secondary material for the database as it was felt that the process of raising an

order and waiting for a reply was too lengthy for many teachers to bother with. In the longer term, it was hoped that free material might be ordered 'interactively'.

Teacher collaboration was sought to produce materials of immediate use in the classroom, which were easily available, topic based, referenced across the curriculum and supported by graphics. Industrial contacts were hand picked, often on the basis of personal knowledge, and consequently stood a good chance from the outset of being co-operative and working successfully with teachers. It was considered important to make the resources available to examiners and examination boards because '... for the immediate future, one of the most effective ways to reach the majority of young people is through well-established subjects with the highest examination entries' (OVERTURE 1985, p.3). Importantly, data was provided for examiners so that the figures they use in setting questions could be realistic and up-to-date. It was intended that '... the resources will in part be a response to, and reflect as closely as possible, the national developments of the SEC (Secondary Examinations Council), SCDC (School Curriculum Development Committee) and the SSCR (Secondary Science Curriculum Review)' (op.cit., p.4).

From July to October 1985 there was a pre-pilot trial. 300 items were tested in ten centres, each subject group producing seventy-five items of less than 800 words, including line diagrams, all of which were indexed. During the Autumn of 1985 each subject group produced 500 items, giving a database of 2000 items which was publicised in the latter part of 1985 and launched at the annual meeting of the ASE in York in January, 1986.

Subject groups were less than ten, with at least three practising teachers. The Industry Education Unit of the DTI

made funds available to OVERTURE for a number of regional projects, all of which depended on the association of teachers with industry with the aim to produce resource items. One of the most successful ways of establishing a group was to adopt an approach similar to that of the Science Research Council: invite bids for a sum of money from a school or group of teachers to produce materials within a given area. As a rule of thumb, £10 per resource was available, and teachers were prepared to give their expertise in return for funds to enhance the work they were doing within a department: typically £500 for fifty resources. Alternatively, the project used DTI funds to support curriculum initiatives by well-established, national groups, such as The Solar Trust and the National Childbirth Trust, charities who made good use of fairly small sums to cover printing costs etc.

Most of the material generated was included on the database. There were particular editorial skills needed to prepare items for an electronic database and the three editors were 'distinguished teachers with young families', temporarily out of the profession. They valued the opportunity to continue involvement in a national curriculum development and attend occasional meetings in London, while the project had the benefit of their expertise, which would have been difficult to arrange had they been teaching full-time. A pilot study was undertaken to investigate this potentially rich but under-used source of professional help - science and maths teachers temporarily out of the classroom, or who have left the profession on retirement or for other reasons. The cost implications of establishing this 'cottage industry' were examined.

In addition to full members of the subject groups, there were corresponding members with experience in the field.

The Group Chairman had a co-ordinating role, and responsibility for the database resided with the Database Working Party under David Bevan (Resources Manager), and for examinations with the Examiners' Workshop Working Party which organized three series of workshops: for chief examiners, for industrialists and for examiners going into industry for a day to identify 'industrial techniques and processes which involve and illustrate principles used in secondary school science ...' (OVERTURE 1985, p.9) and to generate questions. Companies responded by sending to meetings management at the highest level, often managing directors, personnel directors and training managers. The annual analysis of 'O' level and CSE examination questions begun in 1981 revealed about this time '... signs that a swing towards questions more immediately relevant to 16+ candidates has begun.' (op.cit., p.10).

During 1986 it was intended to expand the database from 2000 to 5000 copyright-free items, including original contributions, resources or abstracts produced outside OVERTURE, information and sources of articles, publications, films, videos etc. and, responding to the work of national bodies mentioned above, that the resources should provide for practical applications and assignments, problem-solving exercises, projects, school assessment, examination questions and data interpretation. Active recruiting was aided by the production of a resources package (OVERTURE 1986B) to give a full picture of the Study, examples of the resources sought and easy access to the Study by including registration forms. 5000 copies of the Working Paper and Progress Report (OVERTURE 1985) had been issued to individuals and about an equal number distributed at conferences and meetings.

Some 1 950 science and maths teachers volunteered their services to build up the bank of resources. "Helpers" in

industry were then matched with a "twin" teacher using a computer donated by ICL.

The process for the production of an item may be summarised: idea by industrialist; teacher twinned; industrialist checks draft for technical accuracy and the 'spirit of the idea'; teacher amends; item passed to the subject group where it is edited, trialled and passed to the Resource Director. First-hand experience of the item in use, teachers' and pupils' comments and frequency of use act as quality controls. Teachers were invited to indicate the target age-range on the 'header form' which accompanied their item, and the referee was asked to comment. Often this resulted in the age indication being raised, particularly if the item originated from a non-teaching source. The official target audience was 11-16, though some of the material is suitable for upper school pupils. Half-way through the project an analysis was made to identify any shortfalls, and they appeared in the lower ability, lower age-range. This was then corrected by the grants which were made during the second year.

As a result of the trials, a number of possible modifications to the system emerged, including the need for graphics, interaction with the system, use of colour and compatibility with other systems for schools. The findings of an enquiry commissioned by the Study into the requirements of teachers (DICKER 1985) was discussed in Chapter 7 above. It highlighted the factors considered important by teachers in the context of resource items: relevance, reading age, presentation, type-face and the size and quality of the diagrams.

The Final Report on the Study of Resources and Overture (OVERTURE 1986C) was published in December, 1986 and marked the formal end of the initiative, though funding had been

withdrawn on 31st March, 1986 in view of the heavy financial commitment to NERIS. The first seven pages make detailed recommendations for the structure of NERIS and outline the successful methods for developing and collecting resources identified during the OVERTURE study.

In considering methods of generating new resource items, several new suggestions were made: liaison with other curriculum development groups (ASE, SSCR, TVEI, MEI etc.); collection of published resources (from BP, SATROs, The BBC etc.); facilitating two-way communication between teachers and equipment suppliers; refereeing and appraisal of publications not commonly used in schools; and links with resource developers outside the UK.

The report included a passionate plea that the network of producers and other contacts should be preserved and expanded under NERIS and that it was important to have an interactive database, though the full potential of this had unfortunately not been assessed as the facility was lost at a critical stage of the Study. Moreover, it was recommended that electronic dissemination be the only method pursued, in order to ensure that the resource materials maintain both their relevance and accuracy, and are up-to-date.

The Study showed that this method of generating resource materials is cost-effective, particularly as many teachers gave their time freely. The capital equipment costs were met by the DTI and the telephone charges at local rate are not high, though some LEAs have not released the modems to schools because of the problems they foresee over telephone charges. Evidence from trials is that £30 per term is likely to be an average charge, and even in a school where calls were at trunk rate, use was not time-efficient owing to inexperience and many demonstrations were made to third parties, the charges for a three month period came to only

£55.

PROJECT 3: PHYSICS PLUS

A Summary of the project and an interview with Dr FR McKim at Barton Hill, Marlborough on Sunday, 21st June, 1987.

The Director, Dr FR McKim, though having a background of pure research in solid-state physics, always regarded physics as something concerned with what goes on in the real world and, in school, to be much more broadly based than merely a class-room activity. This led to the joint authorship of a school textbook in the early sixties where applications of physics were written into the text (KEIGHLEY & McKIM 1965) so far as the publishers could be persuaded to include them within the overall budget. As a result of this publication, he was invited to become a member of the Duke of Edinburgh's 'School Science and Technology' committee which surveyed the national scene in the late sixties and set up what eventually became the SCSST (Standing Conference on School Science and Technology), the Director being appointed the first chairman of its executive and finance committee. This formulated the constitution of the SCSST, its principal objective being to try to improve the image of technology and engineering in school science.

The Director has always felt the best approach to lie in emphasising both the pure and the applied aspects of Physics at the school level, rather than instituting separate courses in Engineering or Technology. His subsequent involvement in national initiatives of curriculum development have mostly been concerned, directly or indirectly, with attempts to increase the incidence of applications within physics teaching. One example being his

involvement with a commercial publisher, Nicholas Hunter, in producing sets of slides on applications with background notes under the title Physics in the Modern World.

As a founder member of the SCSST, the Director was asked to give a key-note speech in the Autumn of 1980 in which he reviewed the achievements of the conference over the ten years or so of its existence. (See McKIM 1980, p.18.) As a result of this survey, he felt that a distinct initiative would be timely to provide for teachers' background material on applications which they could use as a part of, or as an adjunct to, their physics teaching. This eventually led to the establishment of the 'Physics Plus' project, with the specific intention of forcing the examination boards to take seriously the matter of including applications in their examinations, rather than just stating their commitment to applications in their syllabuses.

One of the difficulties both teachers and examination boards had faced in this area was the shortage or absence of suitable material, which led to a "vicious circle": examination boards did not find it easy to set questions and so teachers felt that they could not spend much time on applications in their teaching. The production of appropriate material could clearly help to improve this situation, particularly at a time when the examination system at 16+ was under review. Indeed, the Director, as a member of the SCSST, was asked to talk to the committee responsible for producing the draft criteria, and was able to support vigorously the inclusion of applications, which eventually became an important feature of the criteria. The thorough-going review of education to 16+ created a receptive climate for these ideas, and it is arguable that even five years previously, similar suggestions and the proposal for a development project, would have been much

less favourably received.

The project was launched in the Autumn of 1981 with Dr FR McKim as its part-time Director, assisted by a part-time secretary. It was funded by the DTI and sponsored by the SCSST (Standing Conference on Schools' Science and Technology). The Director had eight representatives of bodies likely to be interested in the products of the project to advise him and school-teacher writers were subsequently recruited throughout the United Kingdom.

In an article in Physics Education (McKIM 1983), the Director identified a number of factors which provided the context for the project and influenced its inception. These may be summarised as follows:

Physics is an established school subject and the most popular science for boys up to 16+.

Physics as usually taught and examined is a very "pure" subject. In a study carried out for the SSTF (Southern Science and Technology Forum) of physics papers at GCE and CSE in 1981 (SHARPE 1981) it was reported that just over 12% of the questions called for an 'understanding of scientific principles in a technological context' in the widest sense, while only 3.7% of questions involved modern (post 1945!) technology.

The desirability of including applications of physics, such as engineering and technology, within the curriculum for all school pupils is expressed by many in the educational world, e.g. the ASE in its policy statement Education Through Science (ASE 1981), and more particularly, that

the applications of physics should find their place within the physics subject slot in the timetable, e.g. in the Draft National Criteria Report of the Joint Council for 16+ Physics Working Party which was criticised by Sir Keith Joseph, the then Secretary of State for Education, as giving applications insufficient weight in the criteria for assessment (internal communication from the Secretary of State to the chairwoman).

Physics is a very important examination subject at 16+, but the great majority of pupils who study it do not study any applied physics to examination standard at all. During the academic year 1978/9 the entrants for all subjects with a pure physics content (physics, physics with chemistry, general science etc.) at 16+ were 188 281 for CSE and 179 219 for GCE, while for applied subjects (technical drawing, woodwork and metalwork), they were 282 988 for CSE and 124 443 for GCE, giving totals of 367 500 for pure physics subjects and 407 431 for applied science subjects. Another trend had been the development of new courses in engineering science, technology, control technology and electronics leading to examinations at 16+, which accounted for only 57 731 entrants in the same year. (Statistics of Education for 1978/9, quoted in McKIM 1983, p.221).

The 'Physics Plus' project was started in the light of the above considerations with the intention that 'physics-plus-its-applications' should form one component of physics courses in schools up to 16+, the larger part remaining the familiar pure physics. The Director did not address the matter of syllabus content; not that he felt the existing content necessarily ideal, but he regarded the

need to introduce appropriate applications as being more urgent.

After a survey of materials in the area of applications of physics, it was decided to target the project materials at pupils of about 15, who were identified as being particularly poorly served by existing publications, initially in the form of four-sided, A4 "pamphlets". The choice of format was influenced by the economic constraints under which schools operate and the ease with which pamphlets can be kept up-to-date (by withdrawing or updating, say every three to four years) at minimal cost, but there was no intended implication that this format would preclude the development of others in due course or that the project's material would be other than complementary to existing and future wider initiatives. Experience of producing a textbook had taught the Director that it is impossible to build in applications in book format without their rapidly dating. His strategy there had been to select the first example of an application, so that it would retain its historical importance and so not date so quickly. The Director feels more strongly than ever that it is of cardinal importance that what is produced in the way of illustrative material is seen to be current by pupils, as anything which seems old-fashioned immediately detracts from the physics principle or application presented.

At an early stage, the Director held two one-day conferences, in London and in Leeds, where he invited anyone with an interest in the aims of the project to meet together to discuss ways in which it might move forward. It became apparent that teachers were keen to contribute, but many lacked the necessary experience and expertise, so the pattern evolved of matching a teacher writer with a technical expert, though a number of teachers already

possessed the necessary expertise and wrote unaided. Matching proved quite difficult to organize in practice, partly because the Director was responsible for arranging them and he was released from only half of a reduced teaching commitment. Teachers were recruited from the four conferences and from volunteers who wrote in response to advertisements, specialists were contacted directly by the Director for a particular pamphlet and interviewed by him to ensure that there was the possibility of a pamphlet which would be understandable by a fifteen-year-old. The co-operation of companies in meeting requests for expert help varied considerably; on occasion, the Director suspected that the particular application was commercially sensitive when it seemed especially difficult to reach the right expert.

There were often vicissitudes even when the teacher-expert link had been made. The two were mutually responsible for deciding on the treatment and text of the material submitted for publication and organizing the schedule of meetings etc. The early eighties was a period of rapid change within schools, and the resulting pressure under which teachers worked, plus mobility and promotion, often meant that, despite their intentions, it was difficult for teachers to follow through to the publication of a pamphlet, in one case its taking two years. There were sometimes also difficulties in achieving the right balance between expert and teacher influence on the finished product if the teacher's confidence in his own professional expertise was not strong.

The pamphlet in draft was sent to the Director and his assistant Brian Baker, who reviewed it for its physics content, and it was then forwarded to Alec Porch for a review of language, the target's being a 14-15 year-old pupil, though there was no formal evaluation of

reading-age, which the Director feels, anyway, can sometimes be misleading.

The influence of examinations on curricula is widely accepted, and as mentioned above, the Director's principal aim was to influence the examination boards by showing that the 'Physics Plus' materials could successfully be used as the basis of examination questions and by encouraging their incorporation as a component of a wide range of physics courses, which in turn would lead to strong pressure to change the nature of existing syllabuses, perhaps most effectively through examinations. It was felt that a mechanism which allowed applications to be kept under constant review would be vital in the examinations context.

The Director made an early approach to examinations boards to explore how the applications covered in a course could be examined, and two examiners' conferences were held, where first draft and first printed materials were available. Two extreme positions emerged; to require candidates to have read and to know the contents of all the pamphlets and to test their knowledge and comprehension, or to present the material from a pamphlet as a comprehension exercise which could be answered by any candidate who grasps the underlying physics principles and who is used to 'applying' his knowledge. A further problem was raised in the context of syllabuses, concerning a desirable reduction in content if applications were to be given more time, perhaps up to 20% of the course. Though this weighting may have seemed heavy at the time, it found support in the Joint Council draft statement quoted above, and in retrospect appears to foreshadow the increased importance attached to the relevance of science and an 'applications' approach advocated recently by the SEC and enshrined in their national criteria. Moreover, the Director feels that if one avoids specific applications, the reduction need not

be very great in any event.

Subsequently, three examination boards have approached 'Physics Plus' to ask whether they could use material from the published pamphlets as the basis of questions they set. The idea that it is feasible to use applications material as the basis for questions seems to the Director to be well established in examiners' circles, and he feels that one cannot hope for more at this stage. One of his main objectives for the project has thus been realised.

Although many of the pamphlets could reasonably be described as "lesson-ready", the Director also hoped that teachers would use the contents of the pamphlets as they felt appropriate, though he now feels that perhaps some of the language used was a little too sophisticated and that it could have been helpful to define the target age-range rather more clearly. Also, the pamphlets were chiefly information materials with little specific interaction with pupils, an aspect which has been developed by subsequent projects.

The team was careful to identify which particular part of the syllabus a pamphlet covered, and with a projected total of 100 pamphlets, a grid was developed to ensure reasonably complete coverage. There was no intention of specifying what content should be omitted from the syllabus to make room for increased applications. The team was also careful to ensure that a pamphlet did not presuppose concepts which do not form part of a 16+ course.

When printed, the pamphlet was trialled in school to assess its readability etc. The topics were initially grouped under the following headings:

mechanics (particularly from the sports point of view)

pumps/pressure generally
 the motor-car
 weather
 heat exchanging
 domestic life
 medical physics
 the energy industry
 agriculture
 the communications industry (including satellites)
 electronics (via the microprocessor)
 industry (general)

It was considered important that the applications included in the pamphlets should cover the existing GCE/CSE physics syllabuses, and some sixty-four initial titles gave reasonable coverage of each branch of the syllabuses. The Director is conscious that the 'Physics Plus' material does not contain very much specifically relevant to girls, but the difficulty lies in identifying suitable topics and in then avoiding charges of sexism.

Hobsons Scientific agreed to publish the pamphlets as two-colour, multiple copies. Two options for distribution were contemplated: making a copy-right-free master available to schools or selling multiple printed copies at lower cost. The latter had the potential advantage of allowing the inclusion of photographs and some colour. In the event, both strategies were employed because it was rapidly discovered that although the real cost of photo-copying is about the same as the charge for the off-print (about 10p originally), the effective cost is often nominal to teachers and their departments and this became the preferred method. Commercially, this meant that they had to move to an expensive, copy-right free master book, which resulted in just black and white copies. The book published in 1986 contained forty pamphlets in this

form.

Advertising of the materials has been undertaken by the publishers, who sent a sample pack of pamphlets into every secondary school in the country. They also established a link with Esso, who prepared a pack of wallcharts, distributed free, which used material gathered from some of the 'Physics Plus' pamphlets.

There has been no formal evaluation of the project, but the first twenty or so pamphlets were pretested, with the feed-back reinforcing the demand for photographs and questions. Although comments fed back to the Director ranged from the appreciative to the dismissive, the sales of the multiple copies indicates that there has been considerable uptake. Uptake of individual pamphlets is more difficult to assess now the format is a collection of copyright-free masters. The Director would have valued more information, but the structure of the project and his available time, precluded a systematic survey. One way of gaining greater feed-back would have been to involve a teachers' association from the outset, possibly in a joint publication such as was adopted by several other of the case-studies, but the SCSST had firm views about the style and format of the publication it wanted, which made negotiations difficult. Although not envisaging himself undertaking an evaluation, the Director feels that evaluation would be invaluable, both for 'Physics Plus' and other projects. He sees a continuing need for such material, and clearly, experience of what has happened in the past will be useful in determining the direction and scope of future initiatives.

The Director now has an advisory role with the 'Physics Plus' project, the executive administration of the project being undertaken by Stewart Whitefoot, based with SCSST at

the Institution of Mechanical Engineers in London, but he feels that the future of 'Physics Plus' may well be the publication of one or two more collections of forty pamphlets, though the time-scale will depend on the time the new executive administrator is able to give to it as one of several responsibilities. One problem of the bound collection will be the updating of individual pamphlets, which was a particular strength of the original format.

The Director continues to be intrigued by the difference between attitudes towards "applications" here in the UK and abroad. The comparatively poor image of the engineer and technologist has begun to be tackled by placing greater emphasis on the application of science, but whether this alone will cause the major shift in attitude which is necessary remains to be seen. By way of illustration, in 1970 he prepared a booklet on Concorde for Longmans and the rights were sold for translations in French and Danish. The booklet soon ceased to be published here, but the foreign editions are still in print. It appears to be a social rather than just an educational problem - technological disasters often receiving considerable press coverage, while engineering successes are frequently overlooked. Perhaps in the longer term we should be addressing the attitudes underlying these responses.

PROJECT 4: Snippets

A summary of the project and an interview with the Editor, Brian Davies, at The Institute of Physics, London, on Friday 5th June, 1987.

Snippets (Serendipitous Notes in Physics, Physics Education and Technological Sciences) is a magazine for physics teachers, now issued three times a year at the start of

school terms and published by the Institute of Physics. It was initially supported by The Physics Development Trust, established by the IoP with funds obtained from a national appeal to industry, as one of a variety of initiatives to encourage a strong teacher-oriented base in physics education and to reflect the application of school physics in industry. In particular, it fulfilled the pressing need recognised by Maurice Ebison, the then single member of the Institute's Education Department, for a vehicle of communication between the Institute and secondary school teachers.

Snippets was the individual responsibility of Brian Davies, then the Schools Liaison Officer of the Institute, when the magazine was launched in May, 1982, being one of a number of responsibilities he assumed. His background was that of an experienced teacher of physics in school who had become a lecturer in acoustic and vibration physics and in the History and Philosophy of Science at Goldsmiths College, University of London, with additional responsibility for the training of graduate teachers. He had subsequently been seconded to the Institute of Physics, initially for two years, his salary being met by the Physics Development Trust. He had always maintained a particular interest in the "sideways" approach to presenting content: starting from perhaps everyday observations, incidents and experience of students or aspects of science portrayed in films or newspapers and leading through to particular curriculum issues. Having gathered a lot of "extra-curricular" material over the years, especially concerning science and the animal world, he had developed this feature in his own teaching. As editor he was also concerned that science was too often taught very solemnly and felt that a humorous approach could often be more effective, quoting Leo Rosten as saying that 'humour is the affectionate communication of insight'. He tried to let

these ideas permeate Snippets from the outset and feels that humour and enthusiasm for the subject has become one of its most important and most appreciated characteristics, to judge by the comments and kinds of articles now being submitted for inclusion.

The Education Department of the IoP often came across intriguing applications of elementary physics during its operations, and on the basis that 'anything which fascinates one physicist usually delights another' it was felt that such information would interest physics teachers and their pupils. Snippets main concern was and remains the industrial, manufacturing and research applications of the principles of elementary physics, or how these principles apply to the world around us, together with news of activities in physics education and careers information. Readers were also invited to submit "snippets" for inclusion in the newsletter, and typically 60% of the ideas arriving on the Editor's desk will now be from members within industry and some 40% from members in academic departments. These are not refereed, though they are edited and checked for accuracy where appropriate.

The first edition was published in May, 1982 and teachers were allowed to make up to thirty photocopies of extracts from the newsletter for class use, provided that they duly acknowledged authors and sources. The format standardised as twelve pages of A4, off-set lithograph copy, with a coloured outer sheet. This was partly from considerations of cost, partly because the length seemed right for a publication which would be sent out three times a year, and because a "flashy", colourful publication might put teachers off. A simple, give-away format allows teachers to scan a copy for what they might use, and if nothing appeals, to throw it in the bin. In the second edition, in October-November 1982, it was acknowledged that all LEAs

throughout Great Britain had agreed to distribute Snippets to all the physics or science departments in their secondary schools, some 7 000 copies in all. Copies are posted direct to Independent schools and, as a result of a decision by the Council of the IoP, after Snippets Number 7, Autumn/Winter 1984, distributed as inserts in Physics Bulletin to the 13 000 members and fellows of the Institute, though posters and other inserts for teachers are omitted. This has led to some quite erudite correspondence about the theoretical aspects of some snippets! Currently the printing of each issue runs at about 26 000. An important aspect of circulation is the Affiliation Scheme for schools, whereby for £20 a year 1000 schools receive five copies of Snippets and various free items, such as video tapes, posters, special-offers etc. which are funded from the £6 surplus remaining after production and mailing costs. With the concessionary rates which bulk purchasing allows the Institute, the Editor estimates that these items, together with Snippets, could, in a bumper year, represent as much as £50 worth of materials if bought by schools directly. Demand for copies of the newsletter considerably exceeds the availability, and users are encouraged to photo-copy what they require, subject to the conditions referred to above.

From issue No 10, sponsors were occasionally responsible for funding an individual issue, and in return, a short paragraph was included about their activities. The Editor does not just seek financial support, but a commitment from the industry concerned to co-operate in the production of teacher-oriented material. An important benefit of these sponsorships is the implication that industry cares enough about teachers to sponsor the publication, and this may be reflected in the self-image of teachers. The Editor has resisted taking advertising for Snippets, despite the considerable interest in a publication which finds its way

into all secondary school physics departments, because it would inevitably change the flavour of Snippets and might affect the rapport between teachers and the Institute. Also, LEAs agreed, on the recommendation of their inspectors, to distribute Snippets to their schools at a saving of perhaps £1 000 to the Institute, and the inclusion of advertising copy could jeopardize this mutually beneficial arrangement.

From issue No 11 (Summer 1986), an enlarged editorial staff produced the newsletter: Ms Sally Weaver, an historian, with a professional background in publishing, and Ms Jane Lowth, a research physicist were appointed to deal with the bulk of the editorial, administrative and production work. A further change of editorial staff occurred in Spring 1987 when Ms Giovanna Mills, a physics teacher succeeded Jane Lowth in the team. However, even with an enlarged staff, the work on Snippets has to be fitted in, whenever possible, between the many other activities of the Education Department. This involves following up the technical background to ideas originating within the section (by contacting experts within industry or scrutinising learned journals) before writing what is often a very brief snippet, besides collating the news, careers and submitted items in the newsletter.

The editorial team is concerned with language-level, the seriousness of the approach, the length of the article and crucially, whether teachers can use a particular snippet. The intention is not to 'put everything on a plate', but to provide teachers with a basic idea, an unusual starting point, from which to develop their own teaching material, perhaps by further research. More generally, the hope is to raise teachers' awareness of the potential of applications, for example, to encourage reading the daily paper with an eye for the possible use to which cartoons, advertisements

and other items could be put in teaching. Snippets includes items which teachers can use with pupils of different ages and abilities, though there is some difficulty in finding ones suitable for the younger pupil. Indeed, a number of snippets can be presented by the teacher at a variety of levels appropriate for different pupils.

The average length of items has increased with successive editions, often to allow justice to be done to more subtle concepts or language to be used to set a mood or create a humorous effect. However, the newsletter is written for teachers, and so the proportion of snippets which can be photocopied and used directly by younger pupils without teacher mediation is small. One of the difficulties experienced with items submitted by readers from a background of research is that they tend to contain technical vocabulary which is not accessible to most teachers, so the item has either to be reshaped or in extreme cases, rejected.

Gender bias in particular is considered carefully, particularly in the context of the serious shortage of women physicists and after several very critical letters received by the Editor about unwittingly sexist details (e.g. in cartoons) in earlier issues. The two women on the editorial staff certainly help to redress any unconscious imbalance.

The team also has the wider role of making contact with organizations to discover what aspects of their work might be "snippet-worthy", whether they are willing to give others access to processes which might make a snippet, whether they could become involved in the 'Physics at Work' exhibitions, whether they have women physicists who could write articles about their work and to negotiate special rates on bulk purchases of materials, videos, etc.. The

section joins other organizations to ensure it is sent material which can be scanned for suitable raw material for a snippet. In this way more ideas have been amassed than can probably ever be translated into copy.

The majority of each edition is concerned with applications of elementary physics, often of an intriguing or novel type. Within each edition a balance is attempted between aspects which the snippets illustrate: every-day life, industrial applications, humorous articles and the syllabus topics which are represented. Recently, various initiatives have been taken to provide material to support specific options in some examination syllabuses. Indeed, the editorial team have examined some forty syllabuses from the various groups and feel that relevance to syllabus may become an important criterion for deciding which snippets to include in the future. The news at the front of the letter concerns IoP activities and the publication or broadcast of material likely to be of interest to teachers of Physics. The criterion the Editor uses to decide whether material should be advertised is whether it is something teachers will want to use. This leads to the occasional inclusion of materials for which there is a charge, though teachers are advised to examine such materials carefully before spending scarce resources. Often there is also a careers article or poster to raise the awareness of physics teachers of the diversity and wide involvement of their profession in industry and many other aspects of society and to enable them to enhance its image. Titles have included The Inventive Physicist, The Well-balanced Physicist, The Caring Physicist, The Ubiquitous Physicist, The Limitless Physicist, The Versatile Physicist and The Industrial Physicist.

Snippets is popular with teachers: it is free and distributed direct to schools; while the physics is

seriously considered, it takes a non-serious approach; it is the only publication which has solely physics teachers as its concern and allows them to present to their pupils aspects which are well outside the usual textbook topics. The idea has been copied abroad, and parts of Snippets are now translated into at least four languages. A recent development has been for industrial sponsors to agree to provide four-page, colour pull-outs for classroom use, specifically oriented towards syllabus options and giving teachers information which is not readily available elsewhere, taking Snippets to sixteen pages for these issues. One of the nicest comments that has been received by the Editor was sent by a physics teacher who said "Snippets makes me feel that I have chosen the right career".

PROJECT 5: SATIS

A summary of the SATIS project and of interviews with John Holman, Project Organizer and Head of Science, Watford Grammar School, on Thursday, 2nd April, 1987 and David Walker, Evaluation Officer on Monday, 18th May, 1987 in Rugby.

The Project Organizer, John Holman, Head of Science at Watford Grammar School, had written an 'A'-level text book in collaboration with Graham Hill (HILL and HOLMAN 1978) which put chemistry in the context of society and industry, and he subsequently worked as a team-member, writer and editor to the 'Science in Society' project (SIS 1981), published jointly by Heinemann and the ASE. This commitment reflected the attraction these aspects of the sciences held for him at school and which are a continuing major concern of his teaching.

Following the publication of 'Science in Society' and 'SISCON in schools', both sixth-form general studies courses concerned with the interactions between science, technology and society, the ASE appointed a working party to look at the needs of pre-sixteen pupils. Its report, 'Rethinking Science' (ASE 1984A), made certain recommendations which formed the basis of the SATIS (Science and Technology in Society) project, established in September, 1984.

The background to the project may be gauged from a quotation from John Nellist, the Chairman of ASE during 1986, writing in the foreword to the SATIS General Guide for Teachers (SATIS 1986). 'There is a clear consensus within the science education community about need and direction - students in school will benefit from science courses which are set in the real world, which do relate concepts and content to social, economic and technological contexts. There is agreement too that motivation and learning are influenced for the better by teachers who use a variety of styles and approaches in their day-to-day work' (SATIS 1986, p.7). And from later in the Guide: 'Surely, if there is one thing a science education should be doing for these citizens of tomorrow - most of whom will study no science beyond the age of 16 - it is to equip them with the means to consider such (science related) issues in a rational, informed way.' (op.cit., p.13); 'Abstract concepts will be of little use unless their relation to practical applications is made clear.' (op.cit., p.14); '... adolescents find the science they are taught dehumanised, and irrelevant to themselves and their lives ... girls, in particular, are turned away by the impersonal, dehumanised face of science, but attracted to the idea that science can be useful to society.' (ibid pp.14 & 15); 'The impact of science and technology is not

confined to Britain and the prosperous western world: ... emphasising the wider context of science draws attention to this diversity ...' (op.cit., p.16).

A questionnaire was published in Education in Science 'Science in Society - What Next?' (SIS 1984) to elicit suggestions as to what the new project ought to do. The responses as regards material indicated that video was very much the preferred format, but as it is generally a passive medium and expensive, it was not felt to be appropriate. However, six tape/slide starter programmes are currently in preparation.

It was implicit in the way the scheme was established and funded that it would operate on a model of a central director, seconded full-time for two years, co-ordinating groups of teachers who would work voluntarily, with resources for secretarial support and organizing meetings: a not unusual pattern for curriculum development in this country. One lesson learnt from 'Science in Society' was that if experts are commissioned to write material, it is authoritative, but often difficult to read. Since SATIS was aimed at the pre-sixteen pupil, it was felt essential to involve teachers in the writing, since '... these are the people who can best judge what students can and cannot do.' (SATIS 1986, p.16).

Teachers known to the Project Organizer, including former colleagues, members of the 'Science in Society' project and of the 'Rethinking Science' working party, were approached to take part. The ASE suggested some names and those who responded positively to early accounts of the work of the project and during the trials, were drawn in.

Teachers' meetings identified the methodology: a written project (for reasons of cost); enrichment and infusion,

rather than a new course; and short units, designed to take about 75 minutes. Although the approach within any one unit is applications-led, the project's brief from the ASE was to produce resource materials, not a course, and this precluded taking an applications-led approach overall. This approach has the advantage that teachers are able to use the materials no matter to which syllabus they are teaching. When drawing examples of applications from the industrial context, the writers have been careful to emphasize the importance of people in industry through role-play and in simulations; people are often represented as strongly as the processes, which can give vitality to traditionally sterile topics. A particular application may be used in a variety of ways: to provide reinforcement for a concept, assume the role of an exemplar, enable strands to be drawn together at the end of a sequence of work, but it should not represent the only treatment of a concept.

The Organizer was conscious that materials needed to be produced quickly if they were to inform GCSE, so he undertook much of the initial writing himself to produce some models of material for discussion, and avoided establishing expert/teacher pairs, with their need for considerable co-ordination, possible mismatching of partners, and potential difficulties if the teacher was unable to influence what was produced sufficiently strongly. Instead, experts from industry, the universities and the professions were consulted when needed, access being readily provided by the bodies who supported and sponsored the project, and were sent the final version for checking and comment. Examples of the SATIS materials were included in the third session materials of the SEC GCSE Training Manual for Science (SEC 1986) for First Phase Training, and this provided very useful publicity for the SATIS materials showing them in the context of GCSE in a very immediate way.

The aims of the project are stated in the Teachers' Guide (SATIS 1986, p.17) but may be summarised as follows:

to show that science is not confined to the school laboratory and that it interacts with other disciplines.

to show science has a human face,

to develop an awareness of the contributions of science and technology to society, the interactions between them and industry's role in wealth creation,

to show the need to consider the impact of technological activity on the environment and the careful use of natural resources,

to show that real-life decisions are complicated and there is not always a 'right' answer,

to encourage students to argue on the basis of facts and practise various skills.

Writing of students' units began in September, 1984 and continued until December, 1985. The Project Organizer edited drafts for style, reading age, level of conceptual difficulty, factual accuracy and political/ideological balance. Heavy editing was sometimes required to bring the reading-age of the material on target. It was assessed intuitively, though a retrospective study revealed that the average reading age was about thirteen and a half to fourteen, which met the 13-16 brief admirably. Some details of the methodology are given at the end of the chapter. The original intention to flag the intended level of a topic in

the teachers' notes, was not followed up because the feed-back from trials was so variable. Gender bias in the language was looked at, and also in the deeper structure of the topics selected. Usually only "nudges on the tiller" were necessary to ensure that a balanced view was presented. The majority of material which arrived for editing was published, though the Project Organizer had to persevere with some items, virtually rewriting them.

As stated in the Teachers' Guide (SATIS 1986 p.17) 'SATIS is not a science course in its own right, it is not a technology course either.' the units were designed to be "lesson-ready" but flexible, to encourage teachers to make use of them as they wished. The later units, particularly, were sub-divided into free-standing parts to aid this, though it was clearly not possible with role-playing exercises etc. '... units are intended to involve students as actively as possible ... but in general it is left for teachers themselves to decide which units or parts of units will be most appropriate ... (and) units can be made more accessible to less academic students simply by increasing the level of teacher intervention ...' (op.cit., pp.19 and 20).

One of the most striking aspects of SATIS is the variety of recommended ways of using the material in various units: consideration of controversial issues where there is often no "right" answer; discussions, which involve matters of opinion; working in groups; role-play; problem-solving activities; reading activities and practical work. The Project Organizer stresses in the Teachers' Guide that any nationally-published project like SATIS has considerable limitations, and suggests additional ways in which the science curriculum may be made more relevant: teachers writing their own units; visits to local industry; linking with industry; visiting speakers coming into school; using

the media; making the most of audio-visual material; science trails; brainstorming, lecturettes, debates, mini-plays, projects, art work and opinion polls.

The starting constraints on format were that it should be on A4 paper and include teachers' notes printed on different coloured paper at the front. The design then evolved from teachers' suggestions at meetings: two-thirds, one third page columns; questions in boxes; a running head etc. The copyright-free master for photocopying was decided upon because with some seventy units, it was likely that teachers would be selective and this format would offer them the greatest flexibility. A few trials teachers commented that the photocopying proved expensive.

A charitable foundation funded half the project, while the remainder was provided by sponsorship from industry. The Project Organizer felt it important from the outset that the materials should be cheap and that the independence provided by this scheme of funding was important. All the origination costs were paid for by the project, only the paper, printing, binding and distribution had to be met from sales. The original print run was 5 000, a thousand of which were for distribution overseas, and a reprinting is currently under way.

It is too early for a summative evaluation of how students' attitudes have been changed by the project, but an early formative evaluation by David Walker, a Hertfordshire teacher, seconded full-time to the Cambridge Education Department, is being carried out and some of his initial findings are reported at the end of this chapter. The evaluation is beginning to indicate which units have been used most and are successful, though many schools report that they have the materials, but have not used them as yet. The Organizer feels that there is a critical period

after which the materials are unlikely to be used and teachers will not turn to them for ideas, but will go elsewhere. So dissemination is regarded as very important, and a programme of work-shops has been instituted with members of the original writing team going to different geographical locations where teachers can try the SATIS materials and activities. Science Advisers, university departments of education, SATROs and ASE regional secretaries have been circulated and although the response rate has not always been high, about 80 workshops have been organized centrally, with further ones arising from these.

The methodology of teaching about industrial, social and technological aspects of science has moved some way forward in a number of initiatives, but the assessment has limped quite far behind, with very little relevant work having been carried out. As examiners tend to be rather convergent, it is possible that in the early years of GCSE rather traditional questions will be set. The field would benefit from being widened enormously, perhaps particularly into the area of oral assessment. For example, it is difficult to assess students' awareness of the impact of science on the environment through a written question. Perhaps an alternative would be to provide the context through a case-study, but that inevitably involves considerable reading-time and would heavily penalise GCSE students of lower ability by over-taxing their reading and comprehension skills. With oral, teacher-based assessment, one has the opportunity to carry out a SATIS role-play, for example, and for the teacher to assess an individual child's contribution to it.

Although the aims of the project are formally stated in terms of the effect it was intended to have on students (SATIS 1986, p.17), the Project Organizer agreed that the stimulus of the project for teachers to develop their own

local links with industry might be as important an objective in the longer term, while recognising the difficulty of achieving this. He considers that projects have a responsibility to train new teachers to write clearly and enthusiastically and to put ideas across in an assimilable form. The difference between those who write successfully and those who never become involved, is little more than having the opportunity of working with others who are enthusiastic and being given the experience of trying to write. By setting up a successful model, it is hoped that teachers will be able to use it for their own writing, and there is evidence that this has already occurred. Confidence is central to teachers' willingness to become involved in writing, many thinking that their hand-written material could never be printed, and in the long term this might be tackled by running workshops to help teachers to generate their own material. As it says in the Teachers' Guide, 'It is individual teachers in individual schools who are in the strongest position to judge what is appropriate for their class, and to take advantage of local applications and topical issues' (SATIS 1986, p.43).

To allow the project to continue, the Project Organizer is now seconded for two days a week, largely to handle administration, and a colleague is seconded on a similar basis to deal with the new writing of some thirty units. It is expected that when the number of units reaches 100, that some revision and up-dating of existing units will need to take place.

The Project Organizer identified a number of attributes he felt material needed to possess if it were to be used by secondary teachers. It has to be seen to be applicable to and have recognisable links with the curriculum and to talk the language of the curriculum, given that so many are teaching GCSE courses or elementary courses leading to

examinable courses. So much material produced by industry is too glossy, appearing as a beautiful, untouchable, polished product, and also too general, so inevitably teachers think of it more for use when a colleague is absent, or the end of the summer term, and not in daily curricular terms. Material has to be intimately interwoven with the topic a teacher is presenting. It has to use the same terminology and deal with the same concepts that a teacher would develop when covering the topic, but not go beyond them or fail to include them. Industry is usually keen to "show the whole picture", but many processes are highly interdisciplinary, and teachers find that only a small part of the material is relevant to their subject or appropriate for a particular group.

He feels a way forward is for industry to use teachers as consultants from the earliest phase of a project, to establish the curriculum links and target particular aspects of industry's operations for the basis of material for use with specific pupil groups. He identified some ICI films in chemistry as being particularly well targeted to specific curriculum topics, while others, which deal with chemistry in a more general sense, although visually attractive, were destined to be used in "gamma" rather than "alpha" time, contrary to the intentions of the producing industry. He also felt that in order to engage with pupils, videos should not be too much like works of art, but need to stop and ask questions periodically.

The Project Organizer hoped that the various initiatives in the area of electronic databases would be successful, but expressed certain reservations about their viability for disseminating material. He felt that they had a comparatively 'high activation energy' for use and that the form of the material on the database was too limited by the technology as yet. A complementary technology of making

databases available to teachers on disc has been initiated, but is still at an early stage of development. Two important ones are the OVERTURE abstracts of periodicals discs and the KEY project from the Independent Television companies.

The project has begun a major evaluation exercise which it initiated by appointing Mr David Walker as Evaluation Officer in January, 1987 with the intention of his being seconded full-time, though for various organizational reasons, he worked three days a week on secondment from his school in Hertford until adequate cover could be acquired to allow his total secondment to the project.

Initially, he has travelled the country interviewing teachers and students about their use of and reaction to the SATIS materials. He used a semi-structured interview strategy, which encouraged comment and anecdote since a major object of this work was to facilitate the framing of a questionnaire which is to be sent to teachers in 500 schools, representing a statistically significant national sample. It is hoped to encourage a high response rate from teachers by including a s.a.e. and offering the chance to those who reply to win sets of the next SATIS units to be produced. Another aspect of the Evaluator's initial research was to carry out a detailed retrospective analysis of the seventy published SATIS units.

As mentioned above, the reading age of each unit was assessed by the Project Organizer, but David Walker used a variety of analyses to determine not only the reading age (using the Fry readability test, based on numbers of syllables in words) but also the conceptual demands of the unit, using two measures which he has devised, based on the number of verbs and the number of scientific or technical words used per sentence. There is good initial validation

of this method of analysis, as teachers' perception of units' reading age and their use of the units in practice, frequently reflects the results of the two measures. Another factor which is thought to be of considerable importance for the readability of a unit is the length of paragraphs: these must be reasonably short, and rarely extend beyond half a page.

A number of preliminary, and necessarily tentative, recommendations for possible modifications to the units have emerged, though the questionnaire survey will doubtless inform and illuminate them considerably.

Questions: these tend to fall into two categories; those requiring comprehension, using material in the text, and those requiring application of the ideas contained in the material or speculation, having established certain principles in the unit. It is thought that classifying the two sorts of questions will allow teachers to find parallel paths through the units, which are suited to the needs and abilities of their students. There is some indication that teachers are deterred from using some units by the difficulty of some of the questions, and there is little evidence as yet that they are recasting the units for their own use in a significant way at present.

Much of the student activity associated with the units is concerned with handling data, which in turn demands data gathering (17/70 units) and data management (37/70 units), the latter being valued by teachers as material for homework. There is comparatively little practical work as an essential part of the units (perhaps 13/70), and the Evaluator feels that since teachers very often have clear preferences for the way they carry out their teaching via practical work and that practical work is well resourced, that future units of SATIS should perhaps not include such

activity explicitly.

Teachers have reported some dissatisfaction with the open-ended nature of some of the discussion based units. 24 of the 70 units do not provide for a drawing together of the threads at the end of a discussion. The techniques of using the production of a poster, devising an opinion poll, taking a vote, having to resolve a problem by taking decisions (adopted in 7/70 units) were all strategies which teachers found helpful, and it is recommended that future units use one such method to focus the concluding stage of discussion exercises.

One of the most radical techniques advocated by SATIS units is that of role-play (7/70 units). Many teachers reported that it worked well, but some were very unconfident about their ability to run (and control!) such an activity successfully. The Evaluator feels that perhaps more help in the Teachers' Guide would be appreciated, but that the most effective way to help teachers adopt this often novel approach is via in-service training, where role-play can be practised in the 'protected' environment of colleagues.

Some units involve a large number of 'shifts of mode' in the type of activity demanded of the student. David Walker has devised a method of analysis which can display these modes and the changes between them, in an attempt to facilitate the production of units which do not demand such heavy 'intervention' by the teacher or stress the student.

The full report, based on the survey analysis, will almost certainly throw up many other points and insights.

PROJECT 6: NERIS

A summary of the project and an interview with David Taylor, Director of NERIS, on Tuesday, 9th June, 1987 at Maryland College, Woburn.

The Director first became involved at the invitation of the CET (Council for Educational Technology) which, having been commissioned by the IEU (Industry/Education Unit) of the DTI (Department of Trade and Industry) in response to comments by teachers and examiners concerning shortage of certain materials, drew together three consultants under the chairmanship of Mr Leslie Gilbert, CET's ex deputy director, to look at the feasibility of setting up a database for mathematics and science industry-related materials, which would continue the work begun by OVERTURE. The Director's particular brief was to look at the feasibility from the user's point of view: teachers' ability to identify learning materials, the needs and demands of individual teachers, inspectors, librarians, subject associations and those involved in curriculum development, and also, to survey what other work had been done in the field. A second consultant had responsibility for looking at the technological aspects, while the chairman and lead-consultant pursued enquiries at a level commensurate with his experience as deputy-director of the CET.

At the time, the Director was a senior inspector for Bedfordshire with responsibility for educational technology, and had set up its Media Service, which was concerned with making the best of existing learning resources and creating new ones. He had worked with CET in East Anglia on the CLAIRE (County Links Access to Information about Resources and Expertise) project and his interests and activities over a ten-year period came

together to inform the feasibility study, which he pursued as part of his work for Bedfordshire and partly in his own time.

A previous, unpublished study by Mr Michael Gould in 1982 for the CET had suggested that there was a need to draw together teacher-produced materials for the curriculum and to develop a national system for pooling and dissemination. At this stage, the concept of a database was in its infancy and later, when the test database which OVERTURE undertook with British Telecom was carried out, the idea had not been thought through to an operational system.

The research pattern for the CET study was for the chairman to provide a frame-work for the other two consultants' areas of responsibility, which was then followed by a period of research and mutual discussion, at the end of which, writing would begin by section. The chairman would then discuss the draft critically with the author, it would be revised, and the next stage of the research developed. The Director of NERIS feels that without this structure, the study would not have been nearly as effective, dealing as it did with teachers' needs, for which evidence has properly to be adduced.

The work the Director carried out on the user aspects of the database began with a 'list of potential audience' - those of the user-base mentioned above - which he then visited to conduct structured interviews, which in turn formed the basis of his reports. Individuals were sought nationally who were seen as embodying representative opinions. So at every stage, the conclusions were supported by detailed information and the Director was conscious that his experience in working with those setting up learning-resource centres, locating, producing and sharing materials, was invaluable. He also undertook a survey of

what was being done in the field nationally, being able to draw on the work of the CET and the British Library through the chairman.

From this work he identified several projects of note: the CLAIRE initiative mentioned above, written up as a CET report; an unpublished Scottish study of how curriculum development could be supported by information and material exchange; the ECCTIS (Education Counselling and Credit Transfer Information Service) database of courses, with which NERIS was eventually to share computer facilities and a software development programme (see SCDC 1986); and the OVERTURE project (Case Study 2 above). In addition, he examined the practice or attempted practice of some fourteen national databases; their instigation, aims, record-structure and their users' views. Teachers contacting these databases would have been confronted with fourteen different protocols and record-structures (!), which encouraged the Director to analyse the different methods of operation and to devise a record-structure acceptable to all. The record-structure reached by this analysis required little fine-tuning when the NERIS database came to be established, and found ready acceptability throughout the United Kingdom.

The Director felt strongly from an early stage that the database should provide all teachers with information about materials for use in the curriculum and not concentrate on one curriculum area or on one source of materials, and this subsequently became a central feature of the proposals put to the DTI by the consultants.

In discussion with subject associations, teachers' advisers, resource purchasing agencies and other groups, the Director learnt that teachers were forced to spend an enormous amount of time identifying materials and, where

they failed to find them. in creating materials, often only to find that they had already been produced in the same area and sometimes within the same school! Teachers in some 15% of LEAs find the identification of learning materials very much easier because their secondary schools, in particular, have chartered librarians, who are versed in information science rather than just book management.

The Director's experience that many teachers in the profession seem reluctant to accept the learning materials of others as they stand, was also confirmed; having identified suitable materials, they wish to adapt them for their own use with specific pupils. This has the implication for a database that it should include ideas and examples of practice as well as finished articles. The concept or idea contained in an item is often as important to teachers as the completed work-sheet, assignment sheet or information sheet.

The NERIS project used as one starting point the report by David Bevan, which had been commissioned by the IEU of the DTI in the context of the OVERTURE initiative (see BEVAN 1984), and followed this up with an interview with the author in which various ideas raised in the paper were explored. It presented the concept of an electronic database, while summarising the main issues, and was an important factor in focusing the DTI's attention on the potential of a database in disseminating materials and information about materials to teachers. The Dicker report (DICKER 1985) was published too late for it to be taken into account in the report submitted by the three consultants to the CET.

In April 1986, the Minister for IT announced the development of NERIS and on 23rd February, 1987, level one of three levels of NERIS was launched via PRESTEL as a

public service. During the first full month of operation, NERIS was used by teachers to carry out over 4 700 searches. The 'beginner system', Level One in videotext, would seem acceptable to those for whom it was intended - teachers and others who are not computer experts. The development team hopes to launch the other two levels by June of 1988, Level Three being the most powerful. It will operate in non-videotext format and its development is closely allied to that of the CD-ROM.

The NERIS database is intended to contain records of significant value in mathematics, science, geography and social and personal development education by the end of 1988, but already the nature of the producers of material and the nature of teaching materials themselves make it difficult to work within the close bounds of these four areas. The focus of the material is secondary age-range, but the edges are frayed because material can be used at many different levels, e.g. computer software. In the area of science, NERIS has specifically established a primary science network because of the perceived importance of this development. It is intended to extend the scope of the database to cover all aspects of the curriculum for the statutory age-range in due course.

The NERIS organization is divided into groups:

- a development group, which consists of advisory teachers seconded from education and consultants from industry and commerce, concerned with design of systems: computer systems for levels 1 to 3 and the CD-ROM; communications systems such as direct-dialling access; the dissemination system for NERIS and its in-service training programme;

- a liaison officer group: three officers based in

Woburn, one in Wales and one in Scotland, with a desire to appoint one for Northern Ireland in the future:

a thesaurus development group, which is concerned with the controlled structure of the database; developing a control list of language which is used for indexing records and providing a structured list of topics with which the user can search the database;

an assistant editor group of teacher volunteers and others, who are paid to work in their own time on record creation and editing;

groups working within other educational establishments on contract, for instance the group developing the CD ROM;

a group which provides the main-frame support for NERIS;

an advisory committee, consisting of representatives from many areas of education.

NERIS itself does not create material, but through its network of information providers and the team of assistant editors, can make material available as a record and make sure that it is compatible with the database environment. It is also putting development money into projects nationally which are exploring ways of continuing the gathering together of teacher-produced material at local level.

Items submitted by information providers have to meet set criteria. At present, these are communicated to them orally

by the liaison officers who go through a check-list, and arrive at a "gentlemen's agreement" with the providers, but eventually there will be a formal agreement which will be signed and sealed. By March, 1987, some 130 information providers had been accepted, and data-files being prepared included: SCDC Teachers' Fund of curriculum development activities; OVERTURE database materials; BBC Education and ITV Schools files; MSC data-file of TRIST materials and activities; FEU courseware reviews; Special Education file of software reviews; Primary Science data-files; materials produced for a consortium of LEAs; the educational catalogues of several industrial concerns, such as the Electricity Council.

The database automatically keeps a record of which items are accessed and with what frequency, and perhaps more importantly, it also records the incidence of successful and unsuccessful searches, so that areas where the database has been unable to meet demands made of it may be expanded or developed. The "statistics" of usage are printed out once a month and this "mechanical" evaluation of the usage of the database compared with the possible user-base is one important measure of its success. The Director feels that an appropriate pattern of response would be for a liaison officer to identify a source of advice; perhaps a professional or teaching association, an association of advisers, an HMI, university departments with a specialism etc. and then arrange a demonstration of NERIS to discuss the identification of suitable information providers and a focus organization for a network.

The Director has initiated an independent monitoring group to undertake an evaluation on a model which mimics that used by the IBA (Independent Broadcasting Authority) - an independent, national, monitoring group, identified by a third party - looking at the access, operation and content

of the database. The Advisory Committee has also identified the need for an evaluation of the take-up of NERIS, and the Director would feel it appropriate that this should be undertaken by an independent group, perhaps after a year, when the database will have a user-base large enough to make such an evaluation significant.

In the initial stages of development, for the first six months after the minister announced the inception of NERIS in April, 1986, the Director deliberately kept NERIS's profile low; information sheets and reprints of articles sent in response to enquiries. In November, 1986, NERIS was trialled in fourteen LEAs, and this increase in its profile prompted the Director to undertake a series of ad hoc articles to inform a wider public of progress. Following these two stages of publicity, a structured approach to information dissemination has been planned which includes regional conferences, six separate pages for the TES (The Times Educational Supplement) between June, 1987 and April, 1988 and user articles for inclusion in the more obvious user magazines. Also, specific support materials for users have been developed; an overview of NERIS, an information disc, tutorial software, guide to searching level one and a level one tutorial, plus MARVEL, which is the down-loading software for users. Once the direct access system is installed, which allows schools to use the database, paying only for the telephone call at local rate, all chief education officers, chief inspectors, information technology advisers, library centres, teachers' centres, SATROS, SILOS, etc. will be circulated with information about NERIS.

NERIS is funded by the IEU of the DTI until March, 1988 at a cost of £700 000, when the project will have worked towards self-financing. A number of possibilities for moving towards self-financing suggest themselves to the

Director at this stage:

identifying organizations which produce learning materials and information which teachers want, and where the provision of those materials might lead the organization concerned to make money. NERIS would then be offered as a service for which the producing organization would pay, in particular for data-storage and record creation,

there are organizations at the education/industry interface for whom NERIS might represent a means of directing finance into the area of providing information of what is available,

the purpose of the database is to support teachers and curriculum development, and the Director's intention is to develop a database which LEAs might be persuaded to support as a time-saving, enriching, quality service at a cheap rate. An important element in this is the direct access which avoids subscription charges to other organizations (The Director reports that the reluctance of some LEAs to release the DTI-funded modems to schools (some 12 000 at a cost of £1.5M at June, 1987) has been noticeably diminished by the prospect of direct dialling access.),

with the advent of the new technology, a loose confederation of different databases will ensure that a large amount of material is immediately available in a standard, compatible format. NERIS is already part of a confederation with ECCTIS.

At present, NERIS is concerned with textual material, but the intention is that it will move into three other areas:

graphics, software and data-files; which collectively could be termed coded-data. Experimentation and development has already started in all these areas.

Although the graphics available on NERIS at present are confined to characters which can be typed in from the keyboard, work is being undertaken at Woburn and two other centres, notably in the area of mathematics teaching, so that the system will be able to cope with vectored graphics and line graphics. It is not clear yet whether information providers will be able to input their own graphics. The Director's hunch is that it is likely a centre will be developed to cope with graphics for all providers.

For the future, the Director recognises that on-line access to some extent represents yesterday's technology, and expects the technological developments of high-density local storage on, for instance, CD-ROM, laser-read disc, more "user-friendly" software for data retrieval, more dramatic and dynamic graphics, the improved speed of communication and satellite communication to have a major impact on the potential of database material. A CD-ROM system will be under test in Woburn from September, 1987 and will be available commercially by the Spring of 1988. At present, an up-date period of six months is envisaged and the discs should be at 'throw-away' prices, which will hopefully allow them to be available at individual school level.

Also, he perceives a greater spirit of co-operation between those involved in the whole area of information technology, perhaps because of financial implications. The result for teachers will be the beneficial amalgamation of various strands of developments in the area to keep them better informed, and to reduce the number of sources they have to approach for information. However, some schools will never

have modems, so NERIS is anxious to support local intermediary centres for interrogating the database and investigate ways in which individual teachers can receive the output of the NERIS-data on paper or on disc. A potential danger of a database is the centralised control of which material is included on a database. NERIS avoids this by engaging specialists drawn from all levels of the educational world to validate items.

CHAPTER 10

A SUMMARY OF THE STUDY OF THE PROJECTS AND POINTERS FOR
FUTURE PRODUCERS OF IRMPreamble

Considerable detail was gathered from the directors of the projects during interview and there was remarkable consensus on some issues. The principles summarised below are those which seem sufficiently robust and transferable to have the potential to inform existing or future projects. The issues are dealt with in broadly the same order as the questions outlined in the interview schedule (see Appendix C.3), and the numbers in square brackets identify the projects by reference to the detailed accounts of the previous chapter.

Commissioning of the project

In all cases, those responsible for co-ordinating or directing the projects were approached by a company or national body as a result of their involvement and proven track-record in initiatives which either mirrored the project closely or informed the particular area of concern. All had extensive teaching experience in school; three of the directors indeed continued to teach, being seconded to their project full or part-time, and all had achieved senior positions, with administrative responsibility, in their chosen field. In two cases [3 and 5] the directors had been co-authors of science textbooks which introduced an applications approach at a time when it could justly be regarded as pioneering.

The stimulation for their involvement was usually both "situational" and philosophical. Five had been Heads of Physics in a wide range of schools (technical secondary [1], comprehensive [2], independent [3] and selective grammar [5]) which were twinned with industry [2], had a technical flavour [1], or included technology in their curricula [3], and who regarded a 'sideways approach from everyday observations' [4], 'relevance' [5] and 'physics of the real world' [3] as central to their teaching-style. The sixth, a geographer, had been professionally involved in educational technology and was committed to the pooling of information across the curriculum [6]. In addition to these specific stimuli, there were general concerns at the acute shortage of trained engineers and qualified science teachers, the poor image of technology and engineering in schools, the lack of applications-based public examination questions and the demands of the forth-coming GCSE courses and examinations for applications-based materials.

As might be anticipated, the precise timings of the launches of individual projects were determined by the culmination of a variety of factors within the commissioning organization, but the establishment of these organizations themselves may be identified with a national concern for the promotion of increased awareness by schools of technology, engineering and industry which began to take concrete form in the early 1980's and the debate about the new system of examinations at 16+ and its implication for teaching resources. The impression of the general editors of one project [1] was that the number of teachers with experience of industry grew noticeably during the period of their projects (1980-85). Four important national bodies have co-sponsored or initiated all the case-study projects: The Association for Science Education [1 and 5], The Industry Education Unit of The Department of Trade and Industry [2 and 6], The Institute of Physics [4] and The

Standing Conference on School Science and Technology [3].

It is interesting to note that government finance has been made available through the DTI and not the DES [2, 3 and 6] and that industrial funding has been prompted by the personal involvement of a top manager with a professional body or the launch by industry of an independent initiative [1], direct appeal for funds by a learned society [4] or by an industrially supported charity [5].

The different needs identified by the projects are reflected in the strategies they adopted to meet them, but some common or universal concerns are apparent:

that students and teachers should become acquainted with the activities and process of science-based industry [1] and its role in the community [2],

that pupils would benefit from science set in the real world and from a variety of teaching styles [3 and 5],

that materials related to applications should be made available in a form to reach as wide an audience as possible [1, 2, 3, 4, 5 and 6],

that teachers should be able to use the materials no matter what syllabus they were following with their students [1, 2, 3, 4, 5 and 6],

that examples chosen should be up-to-date [1, 2, 3, 4, 5 and 6],

that students should be able to consider science related issues in a rational and informed way [5],

that students should be aware that the impact of science and technology is not confined to Britain or the western world [5],

that teachers should not have to spend a large proportion of their time identifying suitable materials to use in their teaching [2 and 6],

that there is a need for a national system of pooling and disseminating teacher-produced materials [2 and 6],

that examination boards and teachers need access to material appropriate for generating examination questions [2, 3, 5 and 6],

that it is desirable to encourage a strong teacher-base in physics education [4].

The producers identified some additional features in the strategies they adopted which they considered important, but not central, to their approach:

the involvement of teachers with industrial counter-parts in the production of materials might give them a deeper insight and encourage them to establish local links with industry [1],

an electronic database represents new technology to which most schools have access and might stimulate new ways of teaching traditional topics by presenting up-to-date information for teachers to use [1 and 6], though the Director of one project not using the "new technology" [5] fears that that databases may have a high "activation

energy of use" for teachers,

a light-hearted or humorous approach to the subject would allow teachers to present this aspect to their students [4],

the wide range of activities and recommendations might be relevant to other areas of the curriculum [5].

It is interesting to note that in one of the projects [5], teachers' meetings were used to identify an appropriate "modus operandi" and methodology for the project itself. The structure which emerged - a central director, with secretarial support, co-ordinating teams of teacher-writers - is unusual in this country, in the experience of the Director.

Development of Materials

All of the projects relied upon industry to provide information, either directly [2, 5 and 6] or by facilitating expert/teacher liaison [1, 3 and 4]. Generally, companies were recognized by the directors as being very helpful and co-operative, often providing contact and support at board level [1 and 2]. There was sometimes initial resistance because of the potential disruption a visit by teachers might cause to a site's activities, but with backing at board level and a careful explanation of the objectives of the project, researchers and others became convinced of its value and then supported it whole-heartedly [1]. Where an application concerned was commercially sensitive, co-operation was sometimes less than ideal [3] and the right of veto was written into the contract to protect the company's interests [1], though in practice it was seldom invoked.

Expert contacts within an industry were sometimes known personally to the director [5] and frequently selected and approved by him [1, 3 and 5]; this increased the chances of a fruitful liaison. Where industrial sources approach the project [4 and 5], the director is careful to exercise firm editorial control over the type of material accepted, and in one case has established a contract, which lays down the criteria which submitted material has to meet to be acceptable [6].

When exemplar material is presented to industrialists in a stimulating way, e.g. included with a learned journal, they are prepared to write up relevant applications from their area of activity [4] and if approached by liaison officers with a request for material illustrating a particular application, are willing to provide the necessary information, especially if the system for its dissemination is demonstrated to them [6].

A number of successful strategies emerged for attracting teachers to contribute to these projects, which may be summarised as follows:

using a professional teachers' organization to recruit teacher-writers through their publications or direct mailing, e.g. the Association for Science Education [1] and the Institute of Physics [4];

giving teachers the opportunity to register an interest at a conference or (specially arranged) meeting [2 and 3] and following this up with a "resources package" to specify what is required of a contributor and to aid their writing [2];

approaching personal or professional contacts known to the directors from their involvement in earlier projects [2, 3, 5 and 6];

extending invitations to those teachers expressing an interest at an early stage in the project materials or trials of the materials [2, 3 and 5];

the payment of "honararia" to teachers, particularly in periods of unrest within the profession [1], or rather like the Science Research Council, inviting bids for funding from teachers within one school or locality and offering a fee per resource item produced, thereby providing additional financial resources to enhance their teaching [2];

giving those teachers temporarily out of the profession, perhaps with a young family, the opportunity to be involved in national curriculum development, by undertaking editorial work or writing at home as a "cottage industry" [2];

giving teachers the opportunity to work alongside those who are experienced writers to allow their confidence to grow, perhaps during writing work-shops [5].

Where teachers were to be "paired" with a counterpart in industry [1, 2 and 3], the director concerned was careful to establish the link by visiting the industrial site and matching the two individuals [1, 2 and 3], sometimes using a computer to aid the process, by matching geographical area, availability, etc. [2]. The reasons for not forming teacher/expert pairs, were given by the director of one project [5] as the difficulties posed by the considerable

co-ordination necessary, possible mismatching and ensuring the necessary balance between the input of the two. Certainly, those projects where the liaison was highly structured and concentrated into one or two site visits [1], or the two were invited to writing meetings [2], experienced fewer difficulties of mismatch and delay than those co-ordinated at a distance [3]. Some criteria for the successful selection of teacher authors, which complement the above, have been listed in LLOYD 1984, p.132.

Alternative strategies of constantly being on the look-out for likely individuals to contribute material, which is subsequently heavily edited or rewritten [4], or the directors' approaching experts directly for comment on the technical accuracy of material, but not allowing them specific input, except in so far as it was necessary for accuracy or completeness [5 and 6], avoid some of the vicissitudes of the 'pair' method, but demand extensive writing by the editor.

Projects which include material originating from external sources, have identified a number of potential mechanisms for generating items:

collections of published resources - an
"electronic catalogue",

liaison with curriculum development groups,

links with resource-developers outside the United
Kingdom,

and their Directors envisage some of the incidental benefits an electronic system could bring to teachers as being:

access to evaluation and appraisal of publications not normally found in school,

providing a line of communication between teachers and educational equipment manufacturers.

Generally, the projects were remarkably successful in generating materials whatever their chosen method, but certain patterns of organization seemed to be particularly effective. Advanced reconnoitring of the company or site to be visited by the Director, briefing the personnel, selecting potential topics, matching writers and experts, and establishing a schedule for two teacher visits and the writing and editing of the materials, was a pattern which evolved [1]. Providing a controlled environment, with small groups, for teachers to write materials [5] also proved successful. Where the director was seconded full-time to a project and it was his sole responsibility, or at least a major part of it [1,2,5 and 6], progress seemed to be more rapid than when work had to be fitted around other activities [3 and 4]. Part-time directors all reported that work on their project occupied more time than had been scheduled for it.

Other difficulties which were identified included:

the pressure under which teachers work during term-time (echoed in HOLLOWAY 1975), some reluctance on their part to work in holidays and their possible promotion or movement, often led to writing being given low priority [3].

teachers are generally not confident of their ability to write something for publication in the absence of a supportive environment to encourage them to do so [5]. Indeed, the directors of one

project [1] speculate that the reason some teachers may experience difficulties in writing for publication is that they '... are primarily oral communicators to a specific audience, their class, and are not used to communicating with a third party, another teacher, in writing. This sometimes results in the material being presented in a personal and non-transferable way. The immediate feed-back of pupils' questions on what teachers present in class may encourage them to adopt an "ad hoc" approach and this may be reflected in the apparent lack of a logical structure in some of the submitted items.' While all editors reported that there was usually a very wide range of ability represented in submitted items, from the ready copy, to material which had to be virtually rewritten;

it is sometimes difficult for a teacher lacking confidence in his or her professional competence to "stand up" to an expert over matters of educational judgement, such as readability, appropriateness of language and conceptual level, and this sometimes led to an unsatisfactory final product [3];

the technical vocabulary of those with a background in research is rarely accessible to teachers, and certainly not to their pupils [4] and although experts produce authoritative material, it is often very difficult to digest [5].

Design of Materials

The majority of the projects aimed to produce "lesson-ready" material [1, 2, 3, 5, and 6] because there was a general awareness that teachers are often under pressure, and its chance of being used is significantly increased if "mediation" is unnecessary. However, one project [4] wrote for teachers and adopted a "throw-away" format so that they could take the basic idea, or starting point, and develop their own teaching material from it. Indeed, most of the directors hoped that teachers would be encouraged to adapt the materials to meet their individual needs [1, 3, 5 and 6]. SATIS [5] specifically adopted a structure of 'free-standing sections' within an item to make this easier and included two sorts of question - testing comprehension of the passage and application of the ideas or speculation - so that teachers could take two parallel paths through the material. Moreover, many teachers seem unwilling to use any material in its raw state, as discussed more fully below.

Projects were generally targeted towards science [physics in 1 (part), 3 and 4] and the secondary age-range, though NERIS [6] has included mathematics, science, geography and social and personal development to date, and has established a primary science network. 'Physics Plus' undertook a survey which established that pupils of about 15 were particularly poorly catered for by existing materials [3]. Snippets [4], being written for teachers, contains material suitable for pupils of different ages and abilities, and of course material can be rendered appropriate for different age-ranges and abilities by varying the degree of teacher intervention [5].

Establishing reading-age and the target audience was undertaken by a variety of methods, but all involved

pretesting [1, 2, and 5] and/or professional assessment by the writers, editors or referees [1, 2, 3, 4, 5 and 6]. In one case [3], a consultant with a background of teaching 8-13 year-olds was employed. The assessment could only be "intuitive", and only one project [5] undertook a quantitative (retrospective) study as part of an overall evaluation, when the reading-age was established by a variety of traditional tests (e.g. Fry) and some developed specifically for material dealing with technical and scientific topics. The retrospective analysis established a reading-age of thirteen and a half to fourteen, showing the "intuitive" method to be remarkably reliable! Often, target reading-ages were under-estimated by the writers [2 and 3], particularly if originating outside school [2], and at least two of the directors questioned the wisdom of "flagging" reading-age because of inevitable differences between teachers and schools, and the difference teacher-intervention can make, as mentioned above.

One project, OVERTURE [2], undertook a grid analysis half way through the project to identify ages and ability levels suffering a shortage of materials and consequently redressed the imbalance by producing more items for lower ages and abilities.

None of the projects designed their material to be syllabus-specific, with the exception of the modular inserts in Snippets [3], but the science principles illustrated by a particular application could be analysed and cross-referenced in terms of syllabus content (across the curriculum using a structured thesaurus [6]). It was thought important to give teacher-writers the flexibility to decide the format and syllabus emphasis [1], give reasonably complete coverage to the core-syllabus to ensure that the material could be used by teachers of all syllabuses [3 and 5], and to be certain that teachers would

be able to use the material somewhere in their teaching [4]. The author detected a developing awareness among the project directors that materials should become more syllabus-specific, and this view finds support in several quarters. It was reflected in the findings of a survey commissioned by the DTI from the CET in 1981/2 (GOULD 1987) and a study of multi-media resource packs asserts that materials 'should result from a careful analysis of the demands placed upon teachers by curricula and external examinations. The information must be written to achieve the teaching goals identified by this analysis' (LLOYD 1984, p.133).

Few of the earlier projects specifically considered gender bias in their materials, largely because this only occasioned wide concern amongst science educationalists in the latter part of the period during which the initiatives were launched. Thus 'Physics at Work' (1980/1) [1] did not consider gender bias at all; it was not specifically mentioned in the accounts of OVERTURE [2], though the director was aware of the possible problems both of gender and cultural bias from his work at his present school; and the director of 'Physics Plus' [3] was conscious of the need to avoid gender bias, but found difficulty in identifying topics deemed of interest to girls and avoiding charges of sexism having done so (!); while the editor of Snippets [4] became aware of unconscious gender bias as a result of heated correspondence from women members of the Institute of Physics who received early editions, and subsequently was able to try to avoid it, helped by the two women members of the editorial team. Gender bias was specifically considered by the director of SATIS [5], together with political and ideological balance, one successful strategy being to represent the people in an application as strongly as the process, which has the additional potential advantage of revitalizing otherwise

rather sterile topics. The requirement to be even-handed was built into the information providers' contract in NERIS [6], the most recent initiative. There is evidence (PAGE & NASH 1980, p.12) that where school staff 'make strenuous efforts to make physics more attractive to girls ... this may lead some way towards equalising the differences in attitudes between boys and girls'. It would clearly be desirable for any future projects to consider gender, ethnic and cultural bias explicitly.

Two factors have been identified as having a predominant influence on the format and graphical design of the materials produced by the case-study projects; cost, if they generate printed materials, and technical limitations, if materials are transmitted by an electronic database.

Initially, 'Physics Plus' [3] issued multiple off-prints of individual pamphlets. This has the advantage of a lower unit cost than photocopying, allowing colour, better-quality photographs and ready up-dating of individual pamphlets as the need arises. A difficulty the publishers experienced very quickly, however, was that teachers photocopied sets of pamphlets issued 'on approval' and the already narrow profit margin was eroded entirely. This led to their withdrawing approval sets, and publishing a bound copy of forty pamphlets (in this case at comparatively high cost), so coming into line with the other projects [1 and 5].

The copyright-free master has several advantages for the teacher: it allows a large amount of material to be held in school ready for duplication, perhaps at short notice; it allows the material to be used flexibly and selectively, perhaps as the basis for a teacher's own work sheets; it is often much cheaper in real terms than multiple copies, because photocopying charges are not always attributable to

a particular department. and making photocopies is a more routine part of school administration than raising a number of official orders. On the debit side, some teachers complained that photocopying is expensive [6], photocopies can appear 'dull and uninspiring' and lack "impact" [1]. Indeed, the general editors [1] are coming to the view that 'if a project is to excite and enthuse children about industry, it needs visual impact, which black and white line-diagrams are not easily able to create ... industry seems generally willing to bear the greater cost ... (which) is often lower than teachers appreciate, especially if printed in large quantities, and colour allows greater density of information ...' and '... if a company's educational publications are dowdy compared with those explicitly promoting the company, they carry an implicit message for teachers - they are regarded as less important.'

The design and layout of documents varied. The ASE, a partner in the three projects of case-study 1, had a "house-style" designed to be cheap but serviceable which influenced the format adopted. Evolution over the life-time of the three projects resulted in a three column grid, which allows illustrations to be one or two columns wide and marginal notes, larger print-size, a second colour and a "cleaner", more open format. The general editors commented that commercial publishers are not normally able to justify so much 'empty space'. The other two projects producing printed material adopted a single [3] and dual-column [5] format.

The greatest single technical limitation of electronic database systems at present is the comparatively poor quality of the graphics which they are able to handle; often only what can be typed in from a terminal keyboard. Developments promise improvements, such as vectored

graphics and other coded data techniques [6] and the advent of high-density local storage of information, perhaps using CD-ROM or laser-read disc, must give the potential at least for high quality, coloured, animated illustrations. The problem of transfer to hard copy will remain, though the arrival on the market of a low-cost laser-printer may make the production of "printed quality" copies a reality in school.

In all the case-studies, editorial control was exercised over contributions submitted to the project, and in three [1, 4 and 5] there was an attempt to produce some consistency of style. However, all the projects credited the authorship of individual items, so provided they met the general criteria of the project, some differences of emphasis and style could be tolerated.

The pricing policy in all the projects was to keep the cost to teachers low, and even in the one project published commercially, 'Physics Plus' [3], the publishing house concerned kept profit margins to a minimum as it wanted to broaden its scientific educational base. Only in one case, Snippets [4], was the material supplied free to teachers. Generally, a small charge is considered expedient to avoid projects' falling victim to the "magpie" syndrome. Mostly, origination costs were met by a third party: industry [1 and 5], a charitable foundation [5], subscriptions to a learned society [3], or government grant [2 and 6], while teachers were asked to bear the cost of paper, printing, binding and distribution [1 and 5], purchase at reduced rate [3], affiliation scheme fees for multiple copies [4] and telephone calls at local rate [2 and 6].

NERIS hopes to continue to offer a "free" service by moving towards self-financing in the longer term. Possible strategies include: asking contributing organisations to

pay a fee; acting as a channel for finance by those at the education/industry interface; moving to a position where LEAs would wish to support the database service financially; and establishing a confederation of databases, and charging for access by non-primary users.

Evaluation

The need for a summative evaluation of IPRM and IRM has been succinctly expressed by the General Editor of Case-study 1: 'final examination of a project is important both from the educational standpoint and from the company point of view. Did all concerned achieve their objectives?' (PHYSICS AT WORK 1980B, p.21). However, evaluation, either formative or summative, was not generally a significant part of the structure of the projects in the case-studies. Typically, the directors were too busy co-ordinating the project to undertake a thorough-going evaluation, and as one director pointed out [6], the most useful form of evaluation is a large scale study of the use of the materials and this cannot be carried out until the project is well-established. In the case of his project it was too early, though a mechanism for a "mechanical" evaluation has been built in to monitor which items are accessed, and perhaps more importantly, the incidence of unsuccessful searches of the database.

In all projects, except Snippets [4] and one of the data-bases [6] where it was not appropriate, the materials were pretested in school prior to the final versions being prepared. In the case of OVERTURE [2] there was a pre-pilot trial to pretest the database system. The pretesting was more formalised in later projects [5], where evaluation sheets were supplied for completion by the trialling school and for onwards transmission to the referee. In earlier projects [1 and 3], individual teachers trialled their

material, often to assess its reading and conceptual level as much as to gauge the appropriateness of its structure and presentation. Only in one case, GASS [1], were writers sent a follow-up questionnaire some time after the project had finished, and it revealed that few had used material other than their own with classes, and some had not even used their own!

SATIS [5] has seconded a teacher full-time to undertake an evaluation of the materials and inform the production of the next phase, which constitutes one approach to "formative evaluation". This is being undertaken by circulating a questionnaire to a statistically significant sample of 500 schools, with the chance of winning future sets of materials as an incentive to return the completed questionnaire. Even at an early stage of the evaluation, a number of desirable modifications to the materials are indicated: more attention to the discussion aspects of units; greater help needed with establishing the unfamiliar technique of role-play; and the number of 'shifts of mode of activity' within a unit needs to be controlled. No evaluation of changes in pupils' attitudes as a result of using the materials is currently being undertaken, which might in many ways provide a more useful indication of their effectiveness.

NERIS [6] is establishing a national, independent, monitoring group.

Most of the directors received informal comment about their projects, and it tended to be predominantly favourable, which caused at least one director [4] to question its validity! The director of the one project producing printed materials which was not linked with the teachers' association [3], felt that he was denied access to much useful feed-back because of this.

Advertising

Most of the projects brought their activities and materials to the attention of teachers by writing articles in journals they were likely to read e.g. Physics Education, Education in Science, Times Educational Supplement etc. [1,2,3,5 and 6] while those financed by industrial companies additionally received publicity through the catalogue of their educational services [1]. A number established mailing-lists and kept enquirers informed of progress [2 and 6] and a number circulated all secondary schools with samples of the material [3] or with each edition, distributed by LEAs [4]. The SATIS project [5] appreciated the exposure it received by its being included in the GCSE Science Training Manual and the first phase of national training.

Assuming teachers have been made aware of the materials, how can they be encouraged to use them? Low price and high profile are universally acknowledged as the most important factors. Two of the projects [1 and 5] are looking at teacher work-shops to help disseminate the materials more widely. Subsidy by the DTI for the necessary hardware (computers and modems) to access electronic databases has been a "sine qua non" for the wide uptake of these projects, while support materials generated to give teachers the experience of using the database and information about its contents are being distributed by NERIS [6].

Overview and the future

When asked to discuss the reasons which determine whether teachers are likely to obtain and use IRM, the directors were able to indicate a number of factors, though few had

been established using research methodology, and there is clearly scope for further research in this area.

Teachers are generally reluctant to use material they have not written themselves, even when produced by another teacher [1], so they frequently adapt material for their own use. This has the implication that '... it would be unwise to specify a single method by which a resource could only be used' (LLOYD 1984, p.133), and '[materials] should be supportive, not prescriptive. ... Not infrequently, pre-packaged material ... is treated with suspicion by teachers' (KIRTON 1984, p.24). One early indication in the evaluation of SATIS [5] is that practical work is peculiarly 'personal to teachers' and so material in this area may be particularly vulnerable in this respect. This has the implication that projects must provide ideas, as well as finished items [6], material should not be too 'glossy' and 'untouchable' or teachers will feel unable to adapt it and regard it as promotional [5], and videos should stop and involve students, so avoiding being seen as 'works of art'. On the other hand, 'flexible' materials are rarely 'lesson-ready' and this may deter some teachers from using them [2].

Generally, material should: be teacher-friendly [1]; be closely targeted, seen to be applicable, be related to individual subjects and syllabuses and not too interdisciplinary in an attempt to 'show the whole picture' [1 and 5]; use the same terminology and the same concepts that the teacher will be developing, neither going beyond them, nor failing to include them [5]; have recognisable links to, and talk the language of, the curriculum, so that it can be intimately woven with the topic a teacher is pursuing and relate directly to examinable courses [5]; be delivered through a teacher's letter-box if possible [4]; be the product of teacher involvement at an early stage

[5].

One director [5] detects that if teachers do not use materials during a crucial period after obtaining them, they are unlikely ever to use them. He sees dissemination work-shops as a vital element in encouraging teachers to make use of the materials, by creating time in a stimulating and encouraging environment for them to try them out and to adapt them. Industry is increasingly interested in funding the dissemination as well as origination of materials [1].

All the directors of the case-study projects were conscious of the role their materials might play in the development of GCSE examinations, though the general editors of the earlier projects [1] were aware that their materials were not specifically syllabus-related and that teachers had to make the links for themselves. There are signs that examiners are beginning to make use of the materials in setting questions, from examiners' workshops [2 and 6], direct approaches by three examining groups [3] and research that shows that the incidence of 'applications' questions in examination papers is growing [2]. However, one director [5] feels that whereas the methodology of teaching has moved forward rapidly, assessment has lagged behind, and that it could be usefully extended to oral assessment, role-play, project work etc. in science, as case-studies presented as text penalise the less able student. As a teacher has pointed out, 'if we are also to look at the industrial and economic aspects of science, then there probably should have been some reduction in the actual content of science courses, and that is not very apparent at present' (GUARDIAN 1986).

Indications of how teachers' attitudes to applications material might have been changed by the projects are

scarce, but the evidence of the GASS questionnaire [1] does not give grounds for optimism. SATIS has given teachers experience of generating material in groups, and this has led to the establishment of local groups independently of the project [5] and the director of NERIS [6] hopes that funding might be made available to encourage teacher-produced material at local level. The editor of Snippets [4] believes that an indirect benefit to teachers of industrially sponsored material is that it demonstrates industry 'cares' and so helps to improve teachers' self-image, as well as raising their awareness of potential applications for their teaching in the world around them.

Detecting the lasting effects of the projects on those involved within industry is difficult, but where there were teacher/expert pairs, the informal interchange between the two seemed to result in the industrialists having a greater awareness and understanding of the educational background of their more recent recruits [1], and a similar effect has been identified by those in industry who receive Snippets [4] through their membership of the Institute of Physics.

In the longer term, some projects [3,4,5 and 6] have various phases still awaiting completion, or have planned others to extend their particular contributions in the field. One of the directors [3] feels that if significant progress is to be made in making teachers and pupils aware of the role of industry and the implication of industrial applications for science, then we will have to tackle the underlying unfavourable attitudes to engineers and technologists in the UK, and he feels that it remains to be seen whether materials can play an effective role in changing these attitudes.

As was noted above, there is scope for more influential formative or "concurrent" evaluation of projects. A number

of models have emerged which might prove helpful if adopted by those generating materials.

When a project is planning further phases of activity, as several of the case-studies are, it is helpful to canvass the opinion of those who are known to use the project materials. Such a "formative/inception" evaluation was adopted by the 'Science in Society' project when contemplating how best to extend its activities to pre 16+ pupils. It published an article and questionnaire under the title Science and Society - What Next? (SIS 1984) in a science teachers' journal. The replies received helped to shape the project which eventually emerged as SATIS.

One example of concurrent evaluation was that carried out for the multi-media resource pack Alaskan Adventure. The evaluation was unusual in a number of respects: the pack was intended for three countries, the UK, Canada and the USA; and the strategy adopted included observation, interview and questionnaire. 'The hope was that these teachers would use the material in a manner that suited their classes and that the authors could see this method in operation and interview the teachers directly with regard to its success.' The materials were also displayed for three days at a teachers' convention where 'the opinions of many of the teachers attending the meeting from all over the USA and Canada were recorded'. 'A more detailed inspection of the contents of the pack ... was given to a smaller group ... [and] a questionnaire ... was another source of valuable criticism' (LLOYD 1978, p.17). Of course, an international evaluation on this scale was expensive, 'but necessary when catering for an audience spread over such a wide geographical range ... the cost of producing elaborate trials materials is considerable and though ... companies usually write off these initial costs, they remain an important factor' (LLOYD 1984, pp.133 &

135). The inception evaluation which was carried out within this model can make a contribution to the 'problems of producing teaching materials on the highly emotive subject [for example] of nuclear power ... in that the original definition of "need" can be carried out independently of the company and, if necessary, by a body of practising teachers. Also, the philosophy upon which the pack is based ... allows individuals to make the delicate choice of how to develop a topic such as this. ... For any company to make such recommendations would inevitably lead to criticisms.' (LLOYD 1984, p.134.)

SCIP (the Schools Council Industry Project, later the Schools Curriculum Industry Project) established in 1977, also adopted a novel model both for curriculum development and to evaluation. Ian Jamieson, its evaluator, perceived the need for an evaluation which is 'quick, accurate [and] formative to inform policy decisions', but a problem for a large-scale project such as SCIP is that ' this evaluation demand is difficult to combine with the summative role which those interested in greater accountability require' (JAMIESON 1982, p.44). This apparent incompatibility can be overcome, and his account makes salutary reading for anyone planning a large-scale project.

An example of formative evaluation undertaken on a limited sample is found in the work of Gordon Raitt, Director of the 'School Physics in Engineering Project' (sponsored by the DTI), which eventually became the basis for the Physics in Action materials. He used pupil and teacher evaluation sheets with samples of about 300 to 'give ... guidance as to whether the approach ... was found by the pupils to be helpful to them; to find places where the text seemed to need revision; and to find whether the Problems [included in the material] were at the right level or not' (RAITT 1987A). The returns allowed a number of changes to be made

to the materials before publication.

Even if one hopes that the Industrial Resource Materials published by a project are going to be helpful to teachers, the difficulty remains in making sure that teachers are aware of them, obtain them and use them. This is the concern of the next chapter.

CHAPTER 11

DISSEMINATION AND SUMMATIVE EVALUATION OF INDUSTRIAL
RESOURCE MATERIALS

DISSEMINATION

The need for effective dissemination of Industrial Resource Materials has been highlighted in a report concerning school/industry links and curriculum development, produced on behalf of the Building Societies Association: 'the problem seems to be that there is a great deal of material of varying quality available and no proper means of dissemination' (LEESON 1982).

Models for dissemination

The Schools Council Working Party on Dissemination produced a report in 1974 which identified a number of transferable elements likely to promote effective dissemination of a project's curriculum materials, counselling that 'dissemination should be taken into account in the initial planning of a project and form part of its work from an early stage; ... [it] should not be passed off to the publishers' (quoted in NFER 1976). The authors suggested that: dissemination may be regarded as successful when 'teachers understand the project's ideas and materials sufficiently well to use them in schools if they choose to do so' (SCHOOLS COUNCIL 1974, p.10); the dissemination of many projects is less effective than it might be through organizers 'confusing the function of curriculum development with its product ("packages" of ideas and materials). ... but curriculum development is not frozen at this point, ... the process continues as teachers use, adapt and experiment with the new materials and methods' (op.cit., p.11); 'projects speak ... to a large number of

different audiences: advisers, headteachers, class teachers, teachers' centre wardens, [and] initial and in-service tutors in a variety of institutions. Projects need to know how each group responds to the development of the work and establish and satisfy what each group requires in the way of information, involvement and materials' (op.cit., p.12), though they 'were impressed by the real, if unintentional, communications barrier which faces projects when dealing with colleges and local authorities' (op.cit., p.14).

The Working Party distinguished three broad stages in the development of a project:

- a) general interest and awareness,
- b) trial and evaluation of materials,
- c) adoption or rejection,

and recommended that the dissemination programme be planned to match these (overlapping) stages.

It identified a number of factors influencing the take-up of materials: 'with curriculum innovation, adoption rests on changing teachers' attitudes, or the school curriculum, in fundamental ways ... involvement in the project is a most effective way of influencing teachers' attitudes ... adoption [also] rests on the extent to which the school's organization and teachers' colleagues enable these changes to take place ... it is too easy for those outside schools to underestimate pressures of this kind. Even when projects appear simply to be introducing new materials for pupils, there can be problems over new ways of working and new teaching strategies involving quite important changes in teachers' behaviour' (SCHOOLS COUNCIL 1974, pp.16 and 17).

In a paper submitted to the Working Party by Roger Watkins

of Leeds University Institute of Education. It was suggested that in order to give all teachers a vicarious experience based on that of those 'fortunate enough to be involved' in the project, a strategy be adopted whereby 'a set of training materials (prepared during the life of the project) ... would enable adopting teachers to trace all stages of a project's development and undergo at one remove the modification of insights experienced by those actually involved' (SCHOOLS COUNCIL 1974, p.17).

The issues and alternative strategies are discussed at length in the report itself (SCHOOLS COUNCIL 1974) and in a review study of dissemination of curriculum development published for the Council of Europe by the NFER (NFER 1976), and these are commended to those contemplating a project to produce IRM. However, an important point may be noted about the criterion for successful dissemination quoted above: it stops short at the point when a teacher is in the position to make an informed decision about adoption. It will be argued in the next chapter that even when an individual teacher adopts (obtains) a piece of IRM, there are many factors which will influence the extent to which it is used and its importance in his or her teaching; crucial elements in determining the material's effectiveness.

Resource directories of IRM

The research described above which examined the influence of the Directory of Physics Resource Materials (BULLETT 1985) on teachers' uptake of IPRM, indicates that classified information can encourage teachers to increase the amount of IPRM they obtain. Two additional features would render such a directory of increased benefit to teachers: reliable evaluation and a format which allowed frequent updating. Two directories including evaluations

are known to the author: Goldmine - Resources for Teachers (BROWN 1985) including resources available cheaply or at no cost from industry for use in schools and sponsored by BP and the DTI, and Free and Cheap Resources for Schools: a survey and guide (MASON 1984) published by the Library Association, which casts its net widely. The evaluations appear to be written by one person, and so are inevitably subjective, but never-the-less offer some guidance. A preferable model might be to pool the evaluations of a number of practising teachers, and this is the approach adopted by the consultancy service described in the last section of this chapter and the subject of the case-study in Appendix D.1. Interactive electronic databases have considerable potential for allowing the efficient 'house-keeping' of such directories and allowing teachers to order free materials directly. Some of the implications of this were examined in the case-studies of OVERTURE and NERIS in Chapter 9, and a trial of using such a system for a consultancy service is planned by the Surrey SATRO, as described in Appendix D.1.

Initial teacher-training and IRM

The potential of initial teacher-training in any general strategy for improving the familiarization of the teaching profession with IRM could scarcely be over estimated, yet a book entitled Developments in PGCE courses (ALEXANDER & WHITTAKER 1980), written four years after the Ruskin College speech, made no reference to any form of school/industry experience within PGCE courses; it reported the contemporary concern of linking the theory of teaching to its practice. As early as 1977, the DTI discussion paper Industry, Education and Management (DTI 1977) observed: 'teachers generally should be helped to develop an understanding of national economic needs, the role of manufacturing industry and its dependence on the education

services for people of high quality ... clearly the content of teacher training has a part to play. ... There are some indeed who specifically advocate a bridge year in industry for all prospective teachers.' (DTI 1977, paragraph 73.)

During the 1980s, a number of university departments of education gave their courses an industrial dimension. In 1980, Warwick University devised a scheme of industrial experience for PGCE science students with local firms. Amongst other aims, it was intended that 'students should gain the ability to use examples taken from modern industry to illustrate lessons and to have a little first-hand experience' (SCREEN 1981). A scheme at the University of Bath called the World of Work was made available as an option to PGCE students. A foundation phase took place during the PGCE year and an INSET phase was planned for the first two years of a newly-qualified teacher's career. Work experience and university-based studies were combined in the foundation year to 'introduce how links can be made ... how the resources can be of use to the classroom teacher, ... [and] to allow evaluation of a) available materials concerned with school-work links and b) their benefit', amongst other goals, and it was intended that the INSET should include written case-studies, which would be the 'subject of joint discussion and evaluation'. (SCOTT, SELMES & SMITH 1984.) In the event, this period of INSET did not take place (personal communication to the author). The same university was involved in at least two other activities in the area. A concurrent sandwich degree and teacher's certificate course was reviewed in 1981 (EDWARDS & LLOYD 1981) and a multi-media resource pack, referred to in a previous chapter, was developed in the School of Education. The organizer felt that 'members of teacher-training establishments which have involvement with both industry and research could act as the co-ordinators for the creation of such resources' (LLOYD 1984, p.134).

One of the recommendations of an enquiry into The use of IPRM in school and mathematics teaching was that 'research and development be undertaken to develop and evaluate a range of materials on the use of IPRM in schools for use in initial teacher education' (DICKER 1985, p.III). In the same year, Peter Leech wrote about an Industry across the curriculum initiative at the University of Manchester which had taken place during the academic year 1981/2. This 'simulated the role of a curriculum review group in a secondary school which had to frame a response to an offer of help from an industrialist - in terms of liaison and within the curriculum' (LEECH 1985). PGCE students had to design a package to be used and evaluated in their teaching practice, which was subject to joint evaluation in the department. Student attitudes were reported to change as a result of the course, and in particular, they 'found it easier to conceive of using new methods (wide range of resources, including adults other than teachers) in a context which was novel' (op.cit.).

One of a number of double-sided, A4 pages, published by the Royal Society for the encouragement of Arts, Manufacturers and Commerce in preparation for 'Industry Year 1986', was devoted to the initial training of teachers. It was a report of a conference held in Oxford in September, 1985. The rationale for the conference was expressed in an introductory statement: 'clearly, in terms of resource provision and the development of small-scale curriculum development innovation, Industry and Commerce can offer good opportunities, perhaps most usefully as examples for similar involvement later in the teacher's working life' (DOE 1985, paragraph 2.1). A chief inspector HMI stated that CATE (the Council for Accreditation of Teacher Education) had 'no preconceived model for education and industry work in teacher training' (op.cit.), and indeed a wide variety of initiatives was reported.

Gordon Bloomer of Southampton University advanced a rationale for education and industry work in terms of 'education through industry'. An exercise entitled Resources from Industry, which included a knowledge of materials available from industry, provided an introduction to teaching practice activity. (DOE 1985, paragraph 3.7.)

There were outlines of surveys conducted by ICP (Industrial and Commercial Perspective in Initial Teacher Education Projects) at the Universities of Southampton and Bath, and an exercise in Chemistry education, under the title Review and adaptation of industrial materials taken as part of the PGCE course at the University of Cambridge.

The considerable activity in this area is most encouraging, for as Peter Leech remarks in his paper, 'the PGCE course timing [was] important ... before students became too enmeshed in teaching. ... [and the] longest lasting outcome may be the effects on students' thoughts on the curriculum as a whole' (LEECH 1985). There is also the potential for their exercising a positive influence within their teaching-practice schools. It is to be hoped that other university education departments and training establishments will devise ways to give their courses an industrial dimension which involves the review and adaptation of IRM for students' teaching.

In-service training and IRM

The considerations which point to the need for an education/industry dimension in initial teacher-training apply with equal force to INSET. A further recommendation of the enquiry into the use of IPRM in school science was that 'research and development be undertaken to produce case studies of good practice in IPRM use for evaluation

and dissemination through INSET courses' (DICKER 1985, p.III), but the principal constraints on an effective INSET programme are funding and teachers' time. '... The curriculum development needed to capitalize on the contacts [with industry] ... and for related institution-based INSET ... are demanding of teacher time' (LLOYD JONES 1986). One teacher, speaking of one initiative, remarked that 'she is worried ... that in the absence of adequate in-service preparation for GCSE, the SATIS materials demand a great deal of preparation time which may not be readily available in view of the other changes in approach demanded by GCSE courses' (GUARDIAN 1986).

A number of strategies have been advanced for INSET courses, but one of the most promising for the dissemination of IRM is the "cascade principle", used in the Schools Council Humanities Curriculum Project. This has been called a 'training the "trainers" programme ... in essence a series of in-service training courses for teachers, who will then help others in their own locality' (SCHOOLS COUNCIL 1974, p.17). (For a detailed account of the methodology, see NFER 1976.) An alternative, or possibly complementary, model where INSET has the potential to contribute to curriculum development, has been described by David Davies of the Fulmer Research Institute. 'The whole thing has been teacher-driven. We have just helped to keep the work on the rails. We need to foster a small research and development component in the work of all teachers, perhaps taking one or two percent of their time, and allow them to experiment with change on a small scale, to show that it won't threaten their whole way of life.' (Reported in TES 1986.) As mentioned above, it has been suggested that 'projects should produce materials to service their own training courses' (NFER 1976) and these would clearly be suitable for use elsewhere. Industrial managers constitute a valuable resource for INSET which has

often been overlooked, and this aspect is reviewed in SCDC 1987C. ICI reports an interesting INSET initiative of its own, where occasional short courses are run in order to help 'those who take early retirement' decide whether 'to use their scientific qualifications to embark on a second career in teaching' (ICI 1981, pp.5 & 6). Such individuals would be valuable contributors to INSET courses to encourage the dissemination of IRM. The question has been asked, 'when ... college staff are granted secondment or sabbatical leave, is enough emphasis given to the benefits of gaining practical experience rather than the pursuit of academic research?' (TREADGOLD 1977, p.192.) In the area of IRM dissemination, the possibility presents itself for happily combining the two.

An example of INSET, related to a course for school chemistry which used a textbook of case-studies, has been reported from Israel. A one-day meeting of lectures, when teachers decided whether to become involved with the project, was followed by fortnightly lectures, visits to chemical plants and a four day in-service course, which included a detailed discussion of three case-studies, the opportunity for teachers to carry out most of the experiments associated with them and an exploration of ways of overcoming various administrative and didactic difficulties. It was reported that 'pupils have changed their attitude towards the chemical industry as a result of the course ... they are now more interested in industrial matters ... [and for] the first time ... realised that the chemistry taught in school had any relevant applications!' (NAE, HOFSTEIN & SAMUEL 1982, p.21.) A British scheme of INSET, associated with the SATIS project, has involved teachers in a large number of one-day, regional conferences, when they are given the opportunity to adapt some SATIS material for use in their own teaching, in an environment where expert help is to hand and small-group

work is possible. Preliminary indications are that it is proving a useful strategy for encouraging teachers to use the materials.

A number of the case-studies which produced materials through school/industry collaboration (reviewed in Chapter 9), represented INSET for the teachers who contributed to them, and as observed above, involvement of teachers in such projects, or giving them this experience vicariously, would seem a potent way of encouraging teachers to use the materials, despite the reservations voiced by one of the case-studies in this respect.

Much remains to be done in this area, and an approach which created the time for teachers to adapt a variety of IPRM and IRM for their own teaching by organizing one-day, or week-end courses, might have much to recommend it. An obvious source of funding would be a consortium of producers of material, who would also, hopefully, be prepared to contribute to the staffing and running of such an INSET course.

SUMMATIVE EVALUATION OF IRM

As remarked above, despite its desirability, little summative evaluation of IRM has been undertaken. All too often sales are regarded as a satisfactory indicator of the uptake of IRM, but as has been pointed out, 'the fact that packs are bought, certainly does not necessarily mean they are being used' (SCOTT & LLOYD 1979, p.6) and 'even though the number of sales was very high ... this did not necessarily indicate the pack's continued success as a teaching aid' (LLOYD 1984, p.135). Clearly a more systematic and careful approach to evaluation is required.

The use of questionnaires

Two studies have used questionnaires to monitor the response to IPRM. The Power Station Game, prepared at Robert Gordon's Institute of Technology in Scotland, carried out an evaluation of suitability by a simple questionnaire (MILLAR 1979) which explored:

- enjoyability,
- relevance,
- whether decision-making was simple or complex,
- whether the co-operative effect was perceived as being valuable,
- the assimilation of information and the material.

A BP multi-media resource pack, A North Sea Adventure, was the subject of an evaluation exercise by questionnaire. Some 200 questionnaires were dispatched to schools which had ordered the pack, and the reply-rate was 12.5%. The authors concluded that 'it was an error not to undertake some sort of summative evaluation closer to the date of publication' (SCOTT & LLOYD 1979, p.7). Including the questionnaire with the materials is a possibility, though the delay in receiving replies, since they would have to wait until the materials had been used, might make planning the structure of the evaluation exercise rather difficult.

Evaluation networks

One of the recommendations of the study of IPRM use in school science, was that 'research and development be undertaken to establish pilot projects, in association with existing agencies, for example SATROs, whereby a consultancy service is provided on the selection and use of IPRM' (DICKER 1985, p.III), and a pilot consultancy service has been established at the Surrey SATRO within the same

university department. A case-study of this pilot service was undertaken by the author and is included in Appendix D.1.

The consultancy service is intended to operate as follows. A teacher evaluates a piece of IRM (of his or her choosing in the pilot study) in school and completes a standard evaluation sheet provided by the service (a sample is included at the end of the case-study as Appendix D.2). These are then collated and digested centrally for inclusion in a database of evaluations, to which other teachers in the locality can refer. The advantage of a local database is that teachers can approach the evaluators directly for further information, or even to borrow the materials. The study is in an early stage of development, but seems to offer an exciting way forward. The project directors hope to use an electronic database of the NERIS type to allow ready access to the information and updating, but are still providing hard copy at the present time. A research-study is planned to look at the resource implications of using NERIS, which had a "review" capability built into its specification from its inception, or a similar system. It is hoped that the consultancy might be able to provide general guidance to producers of IRM as a result of the evaluations, and perhaps provide a work-book to help teachers make the best use of a particular example of IRM.

The National Association for Industry Education Co-operation in the USA devised A Guide for Evaluating Industry-sponsored Educational Materials in 1976, a transcript of which is included in Appendix D.3. The intention was to 'provide teachers with an instrument for evaluating sponsored educational resources. These supplementary materials may ... actually [be] designed for the classroom or ... may provide valuable background

information but ... not [be] developed specifically for the teacher's use.' It was suggested that the guide would be more effective with the former. The instructions to the teacher read as follows. 'If, after completing your evaluation of those items designed for the classroom, you have no further use for the [evaluating] instrument, the sponsoring organization providing the item would appreciate your evaluation with any comments you might have for guidance in the development of future materials. Hopefully, this will foster closer industry education co-operation.' (NAIEC 1976.) The author takes this to imply that a standard form was supplied to teachers which they returned to the company producing the IPRM. Unfortunately, only the questionnaire was available as a microfiche from Educational Documents. The journal which appears to be the publication of the Association is not available in the UK, no reply was received to a letter requesting further details and the Education Section of the United States embassy had no record of the journal or the Association's activities. It would be interesting to survey the activities of the Association, which would seem to have spanned at least ten years, to learn any lessons which might be applicable to the situation in the United Kingdom.

Despite some interesting approaches to crucial areas of IRM evaluation (relevance to the curriculum, ability range, bias, subject specificity, modes of use, presentation and evaluation incorporated in the material, if any), the author doubts whether the questionnaire would be useful in the UK as it stands. Suitably modified however, some such questionnaire could be a valuable evaluation instrument for teachers, but would probably be more effective if returned to a central consultancy service, who could supply the producing companies with suitably weighted data from a large number of teachers, perhaps even a statistically significant sample, as well as passing on the raw data. The

author has made a copy of the evaluation sheet available to the Surrey SATRO.

A possible model for the format of the printed materials a centralized consultancy service might provide for teachers has recently been used by the Secondary Science Curriculum Review for its Directory of Resources (SSCR 1987B). A loose-leaf file is supplied with single-page descriptions and evaluations of curriculum materials produced by SSCR groups. Evaluations are based on local trials of materials and the opinions of the central review team, and full details, including price and from where it may be obtained, are included. In order to keep the file accurate and complete, two updates are planned at roughly six-month intervals, the cost of which was included in the (substantial) original purchase price. Clearly an electronic database has considerable advantages over hard copy, provided it is readily accessible by teachers.

Although some potential strategies for evaluation have been suggested, the central issue is how one can encourage teachers to use the materials fully and effectively once they have obtained them. This is a notoriously difficult area, and if research is to make a useful contribution to practice, a model which can both identify and measure the extent to which teachers use IRM and regard it as central to their teaching is required. This is the concern of the final chapter.

CHAPTER 12

TOWARDS A MODEL FOR CURRICULUM RESOURCE DIFFUSION,
DEPENDENCY AND UTILIZATION OF IRMBackground

The key issue which permeates the whole of the present research is how teachers may be encouraged to identify, obtain and use in their day-to-day teaching the many resources which can be characterised as IRM (Industrial Resource Material). The role of a theoretical model in this area is both to clarify and inform discussion and to indicate appropriate parameters which could serve as measures of dissemination and utilization of IRM in future research studies.

Defining IRM

First, it is appropriate to expand here on the definition of IRM mentioned in the summary outline of the TASCs project at the University of Surrey (Appendix D.1), where the term IPRM was modified to IRM to include "industrial" material produced by 'companies whose main function is not the publishing of educational material'. The author suggests that this is too wide a definition. Whereas there would be little difficulty in identifying whether a company's main function is the publishing of educational material or not, this would probably lead to the exclusion, for instance, of the 'Physics Plus' materials, published by Hobsons, which would seem perverse. Secondly, no criteria are established for deciding whether material is "industrial"; in many ways the more crucial factor.

The following working definition is proposed:

the term "Industrial Resource Material" (IRM) is taken to apply to any material, which when used in school has, as its chief characteristic, the potential to increase teachers' or students' awareness and knowledge of the context and process of industry or of its role in society.

In practice, this will usually apply to materials provided by, or produced with the active assistance of, an industrial company or confederation of such companies and in the present study, to material used by science teachers. By placing the emphasis on the potential effect of the material, rather than the producer of it, no source of useful material is excluded and criteria are established for judging the "industrial" nature of the material.

Terms and parameters useful in discussion of the diffusion and utilization of IRM

Many of the ideas which inform the proposed model, and some of the detailed formulations, have their origin in a chapter entitled 'Teachers' Perception of their Needs for Resources' in a book summarizing a three-year research and development project, based at the Exeter University School of Education, into the viability of a regional resource centre (WITKIN 1975). By conducting a questionnaire study, Witkin supports his assertion that the degree of access to, and usage of, a resource by a group of teachers, is in part independent of the extent to which it is efficiently deployed in the curriculum. Further, he develops a framework for thinking systematically about resource utilization.

Given the context of a study concerned with the viability of a regional resource centre, it is not surprising that

all the resources teachers might draw on in their teaching were included. The broad classifications encompassed human resources, printed material, audio-visual aids, kits and games, and these were subdivided into about thirty categories.

Access and usage

Teachers were asked to describe their access to, and usage of, a given resource on three-point, qualitative scales:

access:	easy	difficult	no
usage:	often	occasionally	never

This mirrors Question 20 of the Directory questionnaire, described in Chapter 6 above, which concerned the availability and use of audio-visual aids, though it distinguishes access and usage. It is interesting to note that although it was generally found that, for the sample in the study, access exceeded usage (which the author acknowledged was to be expected) for radio, television, records, work-cards and maps, the percentages of teachers having 'easy' or 'difficult' access to a resource and those using it 'often' or 'occasionally', were almost identical for primary school teachers, whereas many more secondary school teachers acknowledged access to the resource than used it. This might be accounted for by subject specialization at secondary level preventing teachers fitting their teaching schemes around the resource, which is often a possible strategy for primary school teachers (see LLOYD 1984, p.131 and SCOTT & LLOYD 1979, p.34), but the important feature is that a significant discrepancy between access and usage is not inevitable.

Since reasonable access to, and readiness to use, the relevant audio-visual resource is a necessary precondition

for a teacher to use a given format of IRM, a wider study of a/v aids amongst teachers of science in secondary schools, using this methodology, could be helpful in informing producers about the accessibility of their materials.

Curriculum resource diffusion and dependency

One difficulty of using the simple parameter 'usage', is that it gives little information about the effect a given resource has upon the curriculum. A similar difficulty arose when interpreting the responses to Questions 15, 17 and 18 of the Directory questionnaire, which dealt with teachers' possession, hiring and ordering of IRM before and after receiving the Directory. Whereas positive responses may imply the degree of usage of resources, no information is gained about the frequency with which resources are used, their importance in teaching specific topics, or how significant they might be in a teacher's overall approach to teaching his or her subject.

Witkin suggests two parameters to give a measure of these aspects of teachers' use of resources: 'curriculum resource diffusion' and 'curriculum resource dependency'.

Diffusion concerns the proportion of the teacher's curriculum in which the resource is utilized. Dependency, the extent to which his or her curriculum (teaching) is dependent upon the resource in question. With a simple modification, this model would seem to be useful in obtaining a measure of the extent to which IRM is used by teachers and its significance in their teaching.

To obtain an operational specification of 'a teacher's curriculum' in the questionnaire study, teachers were asked to list in order of importance for each age-group they

taught, the five most important items (topics, themes, projects, syllabus-items etc.) which they would cover in their teaching during the academic year. They were asked to give the subject and age-range of the group for each of a maximum of five groups. If they specified a main subject they taught to a group, then all items had to apply to that subject.

One could adopt the same approach in establishing the "curriculum" of a teacher in a study to measure the curriculum resource diffusion of IRM. The parameter would then just be the percentage of items listed in which IRM was used, the definition of which is stated above. However, there could be some advantage in asking teachers to draw their 'items' from a standard list, to give some guidance as to the appropriate size of an item and to facilitate comparison. This could be established using the core syllabuses for science and the separate science subjects, though there would need to be flexibility in allowing teachers to include items not in the list. A pilot study to establish operational boundary-conditions and difficulties would be essential.

Dependency is the extent to which a curriculum is dependent upon a resource. In the study, Witkin asked teachers to imagine that they had only the following resources available to them: blackboard, chalk, textbook, exercise book and pencil. Then for each curriculum item they had specified, they were asked to indicate which of three alternatives best described how they would have to alter their teaching of that item if only the listed resources were available.

A measure of curriculum resource dependency for IRM could be obtained by asking teachers to assume that the IRM used in each chosen "curriculum item" were no longer available,

and to choose the consequence for their teaching of the item from:

1. I would have to radically reorganize the whole way of teaching a particular item,
2. I would have to make minor adjustments in the way that item is taught,
3. I would not need to make any adjustments in the method of teaching the item.

The items falling into each of the three categories, expressed as a percentage of total items, would give measures of a high, intermediate and low levels of curriculum resource dependency respectively.

Given the comparatively low present incidence of IRM identified in schools, it is likely that all but category three would have low percentages, so it might also be useful to have a measure of the dependency on IRM of curriculum items in which it is being used. This could be achieved by expressing the number of items (in which IRM is used) falling into each of the three categories above as a percentage of all items in which IRM is used. A teacher with a large proportion of items of high curriculum resource dependency might be expected to be generally more experienced with, and better disposed towards, IRM than a teacher with a large proportion of low dependency items. The two parameters could also be used to identify teachers who might advise fellow teachers in the use of IRM, and complementarily, those who would benefit from INSET in the adaptation and use of IRM.

A conceptual frame-work for analysis of resource utilization

As Witkin suggests, 'A new resource does not enter consciousness and practice in an instantaneous or magical fashion. Rather, we can trace its progress over time, from the point where it first enters the consciousness of the teacher, i.e. he is aware of its existence, to a point much later on when he is realizing its possibilities fully in practice.' '... the developmental process involved in the utilization of a resource should be seen as the gradual assimilation of the resource into the curriculum, from its origin as external to the curriculum, to its incorporation as part and parcel of the curriculum, as totally integral to it. Naturally this process of assimilating the resource into the curriculum is not achieved without the curriculum undergoing changes as a result of the process of assimilation' (WITKIN 1975, p.87). As he remarks, this is deliberately analogous to Piaget's assimilation/accommodation model. (For a succinct outline of this, see RICHMOND 1970, pp. 67 and 68.)

Assimilation of the resource into the curriculum he calls 'curriculum realization', the accommodation (changing) of the curriculum in response to the resource, 'curriculum development'. His contention is that 'full utilization (of a resource) is reached at the point where the relevant properties of the resource and the relevant elements of the curriculum are completely and inextricably identified with one another in practice. Quite simply the curriculum becomes inconceivable without the resource.' '... it is unrealistic to conceive of the curriculum as existing in any way independently of the resources through which it is facilitated and vice versa.' (WITKIN 1975, p.87)

Whilst one must guard against stretching this model too far

for use in a context for which it was not conceived, it does seem to point to a possible framework for viewing the way that teachers take a particular piece of IRM, and also IRM in general, into their teaching.

There are, however, two issues which have first to be examined: to what extent do we view the science curriculum as dependent upon the resources through which it is facilitated and to what extent may IRM be regarded as a single resource?

The dependence of the science curriculum upon resources

We tend to think of the "curriculum" in terms of national criteria and examination syllabuses, which while specifying various aims and objectives of knowledge, understanding, process, content and assessment, do not attempt to identify the means by which these aims and objectives are to be pursued in practice. Teachers are free to adopt various teaching strategies, selecting resources to facilitate them from those available to them. The range of accessible resources can, of course, restrict the strategies adopted, the extent to which a particular resource is used in the curriculum and in turn, the curriculum's possible dependency upon it - i.e. the curriculum resource diffusion and dependency.

Although resource availability may limit or preclude a teacher's taking certain approaches in his or her teaching, it would not generally be regarded as precluding the achievement of specific curriculum objectives. Even if access to a "fundamental" resource (such as textbooks) were denied, it would usually be possible for a teacher to adopt alternative strategies to achieve the particular curriculum objective (e.g. using dictated notes, work-sheets, OH transparencies etc.) even if they regarded the alternatives

as less than ideal. It is unlikely that a teacher would feel constrained to achieve any curriculum objective by the use of specific resources, or indeed, that any two teachers would adopt the same strategies or resources. To this extent, a curriculum objective is independent of the resources through which it is facilitated.

If one examines how a teacher's approach depends on the use of resources in general, one reaches a similar conclusion. A comparatively recent classification of teaching strategies has led to the description of "resource-based" learning systems in which particular emphasis is placed on teachers' use of resources. Here, '... children learn chiefly from materials of one sort or another, either directly or indirectly - the teacher having an intermittent role, though none the less vital' by contrast with a "teacher-based" system of learning where '... a class is arranged to catch pearls of wisdom, and although books, radio, television and computers may be used, these media have an intermittent, ancillary role.' (ASE 1979B, p.7). In the present context, these different emphases would be characterised by high and low curriculum resource dependency respectively. Although they represent clearly contrasting strategies, different teachers might well aim to achieve a certain curriculum objective by adopting either "system of learning". Thus, curriculum objectives would also seem to be generally independent of the extent to which resources are used to facilitate them.

These conclusions apparently contradict the conclusion of the Witkin study that the curriculum is 'inconceivable as independent of the resources through which it is facilitated', but they may be reconciled by a closer examination of what is understood by "the curriculum". The commonly held view of the curriculum as a prescription in terms of curriculum aims, objectives, processes and

content, ignores the fact that for a pupil, the "curriculum" is the sum of experiences which he undergoes during a course, mostly provided or facilitated by the teacher; while for a teacher, the curriculum consists of the activities he or she organizes, even if the majority will be aimed towards achieving specific curriculum objectives. Derek Morrell, who established the Schools Council, said that '... the curriculum, if it exists at all, is a structure erected on the basis of personal relationships' (quoted in CLEGG 1976). Whatever the curriculum strategies adopted, they will be dependent in some degree or other on the resources employed to facilitate them, since all activities require the utilization of a resource, even if it is as intangible as the teacher's voice. Viewed from this perspective, the use of a resource will both influence the curriculum, and be influenced by it, as contended in the Witkin paper.

There is also the question of curriculum objectives which have specific implications for pupils' use of resources. One of the advantages of resourced-based learning quoted in the ASE study above is that 'Pupils are trained to work on their own and to accept responsibility for the organization of their work - a necessary preparation for life-long education ... they feel they are discovering things for themselves ...' (ASE 1979B, p.3). If framed as a curriculum objective, this would clearly have implications for the provision of resources, and it will be argued that some objectives included in the National Criteria and examination syllabuses have similar implications for IRM.

IRM as a single resource

While it is clear enough that an over-head projector, for example, is a single, identifiable resource, IRM (as defined above) could and would take many forms. Indeed it

could be argued that by defining IRM in terms of its potential for realising specific teaching (curriculum) objectives, it has become different in kind from the other resources discussed in the Witkin study. But what of teachers' perception of IRM? Are they likely to regard it as a "single resource"?

The author suggests that the process by which teachers become aware of IRM (companies' catalogues, direct mailing, advertisements, etc. all of which identify the material with industry, technology or applications), its cost (generally free, or heavily subsidised), its format (predominantly printed material in the form of copyright-free masters, or multiple offprints or booklets) and, most importantly, the often specific purpose for which it is used (meeting curriculum objectives directed towards science in the wider context of society), all tend to allow teachers to view IRM as a single category of resource and for it to be useful to characterise it as such in discussion about its utilization. Just as it has been possible to define, by extension, a measure of curriculum resource diffusion and dependency for IRM, so it is useful to extend the conceptual frame-work to allow a description of utilization of IRM in the curriculum.

The influence of National Criteria and GCSE syllabuses on the need for IRM within science curricula.

As suggested above, the "curriculum", in the wider, operational sense, will be the response of a teacher to the various curriculum objectives he or she adopts. Of course, many of these will, of necessity, be coincident with those of the National General and Subject Criteria for GCSE and the syllabuses of the examinations for which pupils are prepared. When one considers curriculum IRM diffusion and dependency, the general curriculum objectives which

teachers will be adopting in teaching at least 80% of the secondary school population become significant.

The GCSE National Criteria for Science document includes under its statement of educational purposes or "aims" that all GCSE Science syllabuses should be designed: '... to enable them [pupils] to acquire sufficient understanding and knowledge ... to recognise the usefulness, and limitations, of scientific method and appreciate its applicability in other disciplines and in everyday life: ... to promote an awareness that the study and practice of science are ... subject to social, economic, technological, ethical and cultural influences and limitations;' (author's underlinings), and under its 'assessment objectives', mirrors these by stating that '... candidates are expected to demonstrate: ... knowledge and understanding of ... scientific and technological applications with their social, economic and environmental implications; ... the skills and abilities to explain technological applications of science and evaluate associated social, economic and environmental limitations.' Each syllabus is also to '... indicate the ways in which it incorporates technological and other applications of science'. (GCSE Science 1985, pp. 3 and 4). The draft GCSE National Criteria for The Sciences: Double Award include 'everyday applications' as well as 'technological applications' under the assessment objectives (GCSE 1987, paragraphs 3.1.5 and 3.3.6).

The GCSE National Criteria for Physics further require syllabuses to 'provide a basic knowledge and understanding of the principles and applications of physics which contribute to the quality of life in a technologically-based society;' and specify that '... applications should pervade the content ...' and 'technological applications and social and economic interactions must be given due prominence in any assessment

scheme ...' (GCSE Physics 1985, pp. 1 and 3).

A discussion of these Science aims and objectives is undertaken in a section entitled 'Contexts for learning in science' in a GCSE guide for teachers of Science, produced jointly by the Secondary Examinations Council and the Open University Press (GCSE, 1986). It makes the point that the aims and objectives outlined above '... are expected to influence significantly the flavour of GCSE examinations and science courses for students aged up to sixteen. Examining Groups will devise new sorts of questions. Teachers will be challenged to relate their students' learning to the real world by drawing on the everyday and technological contexts in which science both solves and generates problems' (GCSE 1986, p.33), and later, 'technological and everyday applications are ... concerned with the practical solutions to social or individual problems that the procedures and products of science can provide'. It also draws out in a useful, diagrammatic summary of assessment criteria relating to "context", the fact that 'at least fifteen per cent of the total marks are to be allocated to assessment(s) relating to technological applications and social, economic and environmental issues, which should pervade all parts of the examination, the greatest emphasis being given to technological applications.' (GCSE 1986, pp. 34 and 35, quoted from GCSE Science 1985, p.4). The Guide identifies various materials which teachers might find helpful in realising these objectives, including the SATIS, OVERTURE/NERIS and chemistry initiatives developed at Chelsea College and the University of York, but interestingly makes no reference to visits, links and the wide range of other activities which might be thought to have the potential to advance these objectives. Perhaps because it is concerned with assessment objectives, and these other activities do not lend themselves readily to assessment.

When one examines how these aims and objectives are translated into the science and physics syllabuses of the various examining groups, some variety is apparent. Universally, the aims and objectives of the National Criteria are reproduced at the beginning of the syllabus-statement, with little or no modification. There then generally follows a broad 'statement of intent' which reflects the National Criteria, for example: 'no separate sections on technological applications and social, economic and environmental implications have been included as it is intended that these should pervade the whole teaching of the syllabus' (LEAG 1986A, p.9 and 1986B, p.9). There is often also a statement about the weighting of marks available in assessments, for example: 'at least 15% of the total marks available will be allocated to assessment relating to technological applications and social, economic and environmental issues' (MEG 1986A, p.5). It is interesting to note in passing that the National Criteria for Chemistry specify that 30% of the total marks available will be allocated to these aspects of assessment (source, HOLMAN 1986, p.46).

Further detail is supplied in some syllabuses by listing applications within the body of the "content" section, immediately after the principles of which they are applications. To take an example, the Physics syllabus of the MEG includes the following principles with applications ():

moments (spanner), pressure (stiletto heels, padded seats, knives), transmission of pressure (syringe, brakes), latent heat (ice in drinks), evaporation (refrigerator, perspiration), convection (hot water systems), insulation (double glazing, cavity walls, wet suits, vacuum flasks),

total internal reflection (fibre optics, light pipes), thermionic effect (TV tube), radioactivity (radio-isotopes in medicine and industry) and numerous examples in the electronics section (MEG 1986B, pp.12-25).

While a somewhat more enterprising list is included in the Physics 'Syllabus B' from the NEA (NEA 1986B, pp.6-11). Most of these applications are traditional ones which have been taught for many years and, indeed, were included in the school physics textbooks of AEE McKenzie, published shortly after the Second World War. There is little here to guide the teacher, and even if all the applications listed above were incorporated in the teaching sequence, they would scarcely "pervade" the course.

The Southern Examining Group produced a teachers' guide to GCSE Physics in which the new aspects of GCSE were outlined and various activities suggested to help teachers approach the novel objectives and assessment procedures (SEG 1986). Activity Two outlines an exercise that teachers might follow to generate material which would achieve Aim 2: 'to promote awareness and understanding of the social, economic, environmental and other implications of physics'. Teachers are asked to select from the subject content list a topic which 'will provide the most suitable vehicle for achieving Aim 2 of the syllabus'. They have then to outline a 'class activity that might be used to achieve Aim 2, listing the resources' they would need. Again, they are given little help in identifying suitable materials or deciding how best to use them.

An example of a more explicit (and helpful) approach may be found in the Science (Modular) syllabus of the NEA. One of the grouped practical and experimental assessment objectives, carrying 5% of the overall marks, reads as

follows:

'Solve Technological Problems: while engaged in tasks requiring the application of familiar science principles to the solution of simple technological problems, candidates should be able to:

identify the parameters of the problem drawing upon familiar science principles and making use of other available resources;

devise a possible solution to the problem;

test and evaluate the proposed solution and if necessary repeat the whole process to obtain a more satisfactory solution' (NEA 1986A, p.8).

The introduction to the modules includes a paragraph entitled 'Technological Applications and Social, Economic and Environmental Issues', where it states: 'major criteria for the selection of material for the modules have been relevance and applicability. Consequently, both the module tests of knowledge, understanding and explanation and much of the assessment of the six practical and experimental skills, will have a significant technological, social, economic and environmental dimension' (NEA 1986A, p.15).

In the Grade Descriptions section, the syllabus lists under 'Information Handling, Interpretation and Evaluation', the following description for a Grade C:

'Interpretation: When tested in relatively unfamiliar contexts, can select the concepts and principles appropriate to a problem and explain unfamiliar technological applications of science.

Evaluation: In technological, social or economic problems or issues of significance often involving complex considerations can identify the significant factors and apply ideas from coursework which are relevant. Evaluates proposed lines of action sensibly, justifying a standpoint on the basis of coursework knowledge.' (NEA 1986A, p.18.)

Having consulted the relevant documents, a teacher is likely to be left with a clear impression of what he or she is being asked to achieve in terms of applications, without knowing quite where to look, or how to go about it. The writers of the National Criteria and the subject syllabuses seem to have included the exhortation to make science relevant, through emphasizing its interaction with society, without a clear idea of how teachers might realise this in practice. Indeed, a paragraph in the National Criteria for Physics under 'Assessment Objectives', gives a sort of rationale for this "deliberate unspecificity". 'Consideration of the interaction of physics with society is regarded as an essential element in any course in physics, and it is anticipated that complete syllabuses will include assessment objectives directly related to this aspect ... However, there is a wide variety of possible approaches. One of the most effective teaching strategies for this purpose is to exploit particular events and interests as they arise naturally in class discussion. ... a close specification of content could undermine the educational purpose of including the topic and convert what should be broad understanding and awareness into rote learning. For these reasons, specific assessment objectives in this area are not prescribed' (GCSE Physics 1985, p.2, author's underlinings). As has been observed, few physics syllabuses actually specify assessment objectives in this area, preferring to make a general assurance of the 15%

minimum weighting.

While sympathising with this philosophy, the author feels that teachers will need specific help in translating these (unwritten) assessment objectives into curricular terms. Of course, one of the most potent and influential statements of any examination syllabus is the annual or biannual communication between examiners and teachers through the medium of examination papers. The sample papers published by the various examining groups have conveyed something of the wide and varied applications of science and the need for students to be familiar with applying science principles in a technological context. Teachers' ability to gain access to, and make effective use of, the many sources of IRM available is likely to be of crucial importance in allowing them to reflect the aims of the National Criteria for GCSE and achieve the articulated assessment objectives of the examining groups in this area.

Curriculum IRM diffusion and dependency in utilization

Measures of curriculum IRM diffusion and dependency have been outlined above, but how does one conceive the assimilation of IRM into a teacher's curriculum and the accommodation of that curriculum to IRM leading to full resource utilization?

At present, most teachers' curricula would be characterised by low diffusion of, and low dependency on, IRM. Many would regard IRM as requiring extensive adaptation before use, to make it consonant with their current curricular objectives; the IRM would be assimilated into their curriculum. Applications would be used very much as "optional extras" to be referred to once the exposition of principles had been established by experiment and consolidated by problem-solving; little modification to the

teaching-strategy of a curriculum item would be required were the particular IRM no longer available.

One could, however, envisage the intrinsic potential of a piece of IRM to motivate and interest students by relating science to the "real world", eventually modifying a teacher's approach to a particular topic, perhaps leading towards an "applications-led" strategy throughout his or her teaching. The curriculum would then have accommodated the IRM.

These represent the two extremes of the spectrum of IRM utilization. In practice, most teachers would choose a "via media". Indeed, it is questionable whether a course which operated under the title 'Science' or 'Physics' could ever utilize IRM fully in all its curriculum items and retain the complete range of curriculum objectives specified for science in the National Criteria, though some interesting work has been carried out at the University of York into an "applications-led" chemistry course, which is due to be submitted to the SEC for approval in 1987 (SALTERS 1987).

It would be unwise to specify an optimum level of curriculum IRM diffusion or dependency; the appropriate level will inevitably depend heavily on local circumstances, the preferences of the teacher and the interests of the pupils. It is also important not to underestimate the potential difficulties.

The SCIP project found that 'teachers resist attempts to change their teaching by new materials' (JAMIESON & LIGHTFOOT 1982, p.57) and Olson has observed that when 'teachers decide to adopt new practices, they face uncertainties about their role in the classroom, the effectiveness of their methods and the purposes of their instruction ... the translation of materials into more

specific terms meant that elements of the project's "doctrine" were either ignored or redefined in more traditional terms' (OLSON 1980). There are practical constraints too. As quoted above, 'with curriculum innovation, ... adoption rests on the extent to which the school's organization and teachers' colleagues enable these changes to take place' (SCHOOLS COUNCIL 1974, pp.16 & 17). Also, 'cutbacks in teacher provision and in public spending make any changes in educational practice more difficult' (JAMIESON & LIGHTFOOT 1981, p.51).

However, it is clear that the demands of GCSE courses in this area and a variety of other pressures, including the continuing scarcity of resources in general and growing school-industry awareness at local level, will encourage the teaching profession to tackle IRM utilization with greater urgency. A conceptual frame-work and parameters for the measurement of operational aspects of this utilization, should have a part to play in shaping effective strategies.

APPENDIX A

Documents concerning the preparation of the
Directory of Physics Resource Materials

- A.1 List of companies contacted as at 4th January, 1985, and the pilot questionnaire.
- A.2 Letter to companies soliciting materials.
- A.3 Advertisement placed in Science Bulletin soliciting materials.
- A.4 Computer programs to enter details of the materials and prepare the data for the FAMULUS package.
- A.5 Letter to producers for checking the details of their entries in the Directory.
- A.6 Two forms enclosed with the letter of A.5.
- A.7 A Directory of Physics Resource Materials.
(BULLETT 1985).

Appendix A.1Companies and Institutions contacted as at 4th. January, 1983.

Aerosol Manufacturers Association
 Alternative Technology
 ASE

BP Educational Service
 BBC
 British Computer Society
 British Gas Corporation
 British Man-made Fibres Federation
 British Nuclear Fuels Ltd
 British Paper and Board Industry Fed.
 British Ropes Ltd
 British Standards Institute
 British Wool Marketing Board

Castrol Ltd
 CEGB
 Ciba-Geigy Plastics
 Copper Development Association

Dept. of Industry - Electronics Applications
 Du Pont

Electrical Association for Women
 Electricity Consumers' Council
 EMI
 Esso Educational Service

Forrestry Commission

Glass Manufacturers Federation

HMSO

IBM
 ICI
 Institution of Metallurgists

Kodak Ltd

London Brick Co
 Lucas Girling Ltd

Man-made Fibres Association
 Metal Box
 Metcon

NW Museum of Science and Industry

Osmiroid Educational

Plastics and Rubber Institute

Road Transport Industry Training Board

Schools' Council
 Shell Educational Service
 STC

Thames Water

Timbre Research & Development Associatio
 Trylon Ltd

UBI
 Unilever
 UKAEA



UNIVERSITY OF WARWICK

DEPARTMENT OF SCIENCE EDUCATION

DIRECTORY OF RESOURCES FOR
TEACHERS OF PHYSICS IN SCHOOLS

The information from these (anonymous) questionnaires will help us to select the types of material which can most usefully be included in the directory and suggest appropriate ways of bringing the completed directory to the attention of teachers.

Your coöperation in completing the questionnaire is very much appreciated.

In which type of school do you teach?

For how many years have you been teaching physics?

1-2 ☐ 3-5 ☐ 6-10 ☐ 11-20 ☐ 21 or more ☐

To how many sets do you teach physics as a subject below the sixth-form?

To how many sets do you teach physics as a component of a science course below the sixth form?

Do you enter pupils for an examination at 16+ which includes physics? ☐ Yes/No

Do you teach physics at 'A'-level? ☐ Yes/No

If you teach any subject other than physics, please indicate which:

1. How do you get information about resource materials produced by industry and other institutions? (Tick those which apply)

By post to your school ☐ From your head of department ☐
At your local teachers' centre ☐ By writing to companies direct ☐
By reading journals/newspapers ☐ Other

Please ring the box of the most important.

2. Which of the following visual-aids do you have available for your teaching on more than an occasional basis?

16mm film projector ☐ film loop projector (standard 8 ☐ super 8 ☐
2*2 slide projector ☐ over-head projector ☐
film-strip projector ☐ video-recorder and monitors ☐
microprocessor ☐

Please ring the box of the one you use most frequently.

P.T.O.

3. Which forms of material produced by industrial companies have you used in your teaching?

work sheets ☐ posters/wall-charts ☐ over-head transparency ☐
independent learning/enrichment packs ☐ films (16mm) ☐
background booklets/data for projects ☐ film loops ☐
film strips ☐ video tapes/cassettes ☐ TV programmes ☐
educational games ☐ computer programs/simulations ☐

Please ring the box of the one you have used most often.

4. If you use films or video tapes, do you
borrow from a free film library? ☐
hire them from a film library? ☐
buy them? ☐

5. Excluding films and video tapes, what is the maximum part of a lesson for which you have used 'industrial' materials?

5 minutes ☐ 15 minutes ☐ half a lesson ☐ a whole lesson ☐
a double lesson ☐

6. For material needed in class sets, would you prefer to:
(a) buy a class set? ☐ (b) have a copy-right free master to photo-copy? ☐
(c) have a banda master? ☐ (d) have an over-head transparency? ☐

Please tick one.

7. Do you use materials produced by an organization not shown on our list which you would like to recommend to other teachers? If so, please give brief details.

8. Which, if any, of the following publications do you read fairly regularly?

ASE Education in Science ☐ IoP Physics Bulletin ☐
School Science Review ☐ Physics Education ☐

Appendix A.2

UNIVERSITY OF WARWICK
COVENTRY CV4 7AL

DEPARTMENT OF SCIENCE EDUCATION

TELEPHONE COVENTRY (0203) 512001
24011

PB/PN

Dear Sirs,

Industrial & Technological Resources
Directory for Physics Teachers

We are establishing a library of materials, published by industrial and commercial companies which have relevance for the teaching of physics at any level in school. It is anticipated that these will include leaflets, resource-packs, educational games, films, filmstrips, tape cassettes, over-head transparencies etc.

In the first instance, we are chiefly concerned with materials which will allow a physics teacher to give illustrations of scientific principles and processes drawn from the areas of industry and technology, and also to provide 'enrichment' for some students in the form of individualised learning.

Having collected a wide range of publications, we plan to produce a ready-reference directory and catalogue so that physics teachers can locate quickly and accurately sources of relevant material. To make such a directory as useful as possible we would hope to give an indication of the following:

1. A brief title to indicate the principle(s) illustrated and an outline of the particular illustrations.
2. The target age range of pupils and minimum reading age where applicable.
3. A description of medium, format, physical size, number of pages, nature of reprographic process etc where appropriate.
4. Cost of materials, if any.
5. Availability of multiple copies.
6. Publisher with correct address and method for ordering.
7. Availability of publishers catalogue, with details of the full range of publications relevant to school science.

Cont'd.

- 2 -

We would be most grateful if you would send us any of your materials which you feel should be included in our survey and information under the seven headings for the directory.

We hope that our project will result in your publications reaching a yet larger number of schools and science teachers.

Yours sincerely,

Peter Bullett

Peter Bullett.

Appendix A.3

EDUCATION

Aiding school science

If your company produces materials which are used in the teaching of physics at any level in schools, then read on! The Department of Science Education at the University of Warwick is aiming to establish a library of such materials including leaflets, resource-packs, educational games, films, filmstrips, tape cassettes, overhead transparencies – specifically, materials which allow a physics teacher to illustrate scientific principles and processes and which would also provide ‘enrichment’ for some students in the form of individualised learning.

Once the collection is complete, the Department intends to produce a ready-reference directory and catalogue, so that teachers can quickly and accurately locate sources of relevant material. Each catalogue entry would include the following information: (i) a title to indicate the principle(s) illustrated and an outline of the illustrations; (ii) the target age range of pupils and minimum reading age, where applicable; (iii) a description of medium, format, physical size, number of pages, nature of reprographic process etc, where appropriate; (iv) cost of materials, if any; (v) availability of multiple copies; (vi) publisher, with address and method for ordering; (vii) availability of *publisher's* catalogue, with details of full range of publications relevant to school science.

If *your* company has not yet responded to the Department's request for catalogues and materials, then the organisers would be pleased to hear from you. Any appropriate materials should be marked ‘Physics Directory’ and sent to the Department of Science Education, University of Warwick, Coventry CV4 7AL. The project should enable your products to reach an even larger number of schools and science teachers! □

Appendix A.4Program 1 - PHYSDIR

```

10CLS
20VDU15
30PRINT"BBC Micro PHYSDIR program"
40PRINT"PF Bullett, 18 Apr 1984"
50PRINT
60INPUT"NAME OF FILE";N$:PRINT
70C=OPENOUT(N$)
80N=0
90REM
100REM
110REM
120REM: TO ADD ENTRIES
130REM
140REM
150REM
160DIM FILES$(2,16)
170 REPEAT
180 RESTORE
190 FOR Y=1 TO 16
200 READ F$
210 PRINTF$;
220 IF F$="SYLL" THEN PROCSYLL:PRINT " ";A$:PRINT:GOTO 280
230 INPUT "A$
240 IF A$="*" THEN SOUND 1,-10,200,10:G$=GET$: IF G$="*" THEN PROCREPEAT:Y=16:GOTO 270
250 PRINT
260 IF LEN(A$)>66 GOTO 210
270 S$=" "
280 FILES$(2,Y)=F$+S$+A$
290 NEXT Y
300REM
310REM
320REM:OPTIONS
330REM
340REM
350 INPUT"CORRECTION (C) OR SAVE TO DISC (D)";D$:PRINT
360 IF D$="C" OR D$="c" THEN PROCCORRECT:GOTO 350
370 IF D$="D" OR D$="d" THEN PROCDISCFILE:PROCSTORE:PRINT"FILE ";N$;" CONTAINS ";N$;
ENTRIES";PRINT:INPUT"REPEAT (R) OR END (E)";P$:PRINT
380IFD$<>"C" AND D$<>"c" AND D$<>"D" AND D$<>"d" THEN 350
390 UNTIL P$="E"
400CLOSE#C
410REM
420REM
430REM: FIELD NAMES
440REM
450REM
460DATA INDX,SYLL,TITL,YEAR
470DATA DESC,AUTH,FORM,REFN
480DATA AGER,COST,PUBL,DIST
490DATA ADDR,REVM,DUMB,DUMC
500END
510REM
520REM
530REM: FILING PROCEDURE
540REM
550REM
560DEFPROCISCFILE
570FOR Y=1 TO 16
580PRINT#C,FILES$(2,Y)
590NEXT Y
600N=N+1
610ENDPROC
620REM
630REM
640REM: STORING PROCEDURE
650REM
660REM
670DEFPROCSTORE
680FOR Y=1 TO 16
690FILES$(1,Y)=FILES$(2,Y)

```

```

700NEXT Y
710ENDPROC
720REM
730REM
740REM: CORRECTION PROCEDURE
750REM
760REM
770DEFPROCCORRECT
780FOR Y=1 TO 16
790PRINTFILES$(2,Y)
800PRINT
810$=GET$
820IF $="C" OR $="c" THEN PRINT"CORRECTION (INCLUDE FIELD
NAME)":INPUT"C$:FILES$(2,Y)=C$:PRINT: GOTO 790
830NEXT Y
840INPUT"REPEAT CORRECTION";$:PRINT
850IF $="Y" OR $="y" THEN 780
860ENDPROC
870REM
880REM
890REM: AUTO FILLING OF SYLL
900REM
910REM
920DEFPROCSYLL
930I$=MID$(FILES$(2,1),6)
940IF I$="10" A$="MECHANICS"
950IF I$="20" A$="HEAT"
960IF I$="30" A$="MOLECULAR PROPERTIES"
970IF I$="40" A$="WAVES"
980IF I$="50" A$="LIGHT"
990IF I$="60" A$="SOUND"
1000IF I$="70" A$="ELECTRICITY AND MAGNETISM"
1010IF I$="80" A$="ELECTRONICS"
1020IF I$="90" A$="ENERGY AND RADIOACTIVITY"
1030IF I$="100" A$="APPLICATIONS"
1040IF I$="110" A$="PROFESSIONAL MATERIALS"
1050ENDPROC
1060REM
1070REM
1080REM: AUTO COPYING OF FIELDS
1090REM
1100REM
1110DEFPROCRepeat
1120FOR M=Y TO 16
1130FILES$(2,M)=FILES$(1,M)
1140PRINT:PRINTFILES$(2,M)
1150NEXT M
1160PRINT
1170ENDPROC

```

Program 2 - BBC>BUR

```

10INPUT"NAME OF BURROUGHS' FILE",N$
20C=OPENOUT(N$)
30INPUT"NAME OF BBC FILE",F$
40B=OPENIN(F$)
50 REPEAT
60INPUT$B,A$
70SLENZ=LEN(A$)
80IF SLENZ=0 THEN 150
90 FOR IZ=1 TO SLENZ
100BPUT$C,ASC(MID$(A$,IZ,1))
110 NEXT
120BPUT$C,10
130IF LEFT$(A$,4)="DUMC" THEN BPUT$C,10
140 UNTIL EOF$B
150CLOSE$B
160CLOSE$C

```

Program 3 - HPUTD

```

10MODE 7
20DIM JX(32)
30PRINT "BBC Micro HPUT program"
40PRINT "Disk version"
50PRINT "JPR Palfrey, 10 Apr 1984"
60INPUT "Which file? " F$
70F1=OPENIN(F$)
80INPUT "What line speed? " LSP%
90IF LSP% <> 9600 THEN 130
100*FX 7,7
110*FX 8,7
120GOTO 240
130IF LSP% <> 4800 THEN 170
140*FX 7,6
150*FX 8,6
160GOTO 240
170IF LSP% <> 2400 THEN 210
180*FX 7,5
190*FX 8,5
200GOTO 240
210IF LSP% <> 1200 THEN PRINT "Sorry, unavailable":CLEAR:END
220*FX 7,4
230*FX 8,4
240REM SERIAL PORT
250ON ERROR GOTO 710
260*FX 2,1
270*FX 3,7
280FHZ=#%
290FHZ=#01000202
300#Z=FHZ
310SEQ1Z=1
320BPZ=0
330REPEAT
340SIGBZ=0
350FOR IX=1 TO 32
360IF EOF#F1 THEN 410
370SIGBZ=SIGBZ+1
380JZ(IX)=#GET#F1
390BPZ=BPZ+1
400NEXT IX
410REM START POINT FOR RETRANSMITTING
420CH1Z=SIGBZ
430FOR IX=1 TO 32
440PRINT "JZ(IX);
450CH1Z=CH1Z+JZ(IX)
460NEXT IX
470PRINT "SIGBZ;
480PRINT "(CH1Z DIV 256), (CH1Z MOD 256);
490PRINT "(SEQ1Z DIV 256), (SEQ1Z MOD 256)
500REPEAT REPLYZ=GET MOD 128:UNTIL REPLYZ > 31
510REPEAT J1Z=GET MOD 128:UNTIL J1Z = 13
520IF REPLYZ <> ASC("Q") THEN 570
530*FX 3,0
540PRINT:PRINT "TRANSFER ABORTED"
550SIGBZ=0
560GOTO 640
570IF REPLYZ <> ASC("A") THEN 410
580IF SEQ1Z = 65535 THEN SEQ1Z=1 ELSE SEQ1Z=SEQ1Z+1
590*FX 3,0
600#Z=FHZ
610PRINT BPZ;" BYTES SENT";CHR$(11)
620#Z=FHZ
630*FX 3,7
640UNTIL SIGBZ <> 32
650*FX 3,0
660*FX 2,0
670#Z=FHZ
680PRINT
690CLEAR

```

```
700END
710REM ERROR TRAPPING
720*FX 3,0
730*FX 2,0
740*Z=FMZ
750PRINT:PRINT "BASIC ERROR ";ERR;" AT LINE ";ERL
760CLEAR
770END
```

Appendix A.5

DEPARTMENT OF SCIENCE EDUCATION



UNIVERSITY OF WARWICK
COVENTRY CV4 7AL

TELEPHONE COVENTRY (0203) 24011

25th June, 1984.

Dear Sirs,

DIRECTORY OF INDUSTRIAL AND TECHNOLOGICAL
RESOURCES FOR PHYSICS TEACHERS

During the past eighteen months, materials have been collected for the above directory from a wide variety of sources. A mainframe data-base, funded by the Institute of Physics, is now established here at The University of Warwick and The Association for Science Education plans to publish the directory in September.

I enclose line-printer copies of the entries referring to materials produced by your organization and should be most grateful if you would be kind enough to:

1. check that each entry is accurate, making any corrections on the printout in red ink
2. complete the enclosed form (or additional copies of it) with details of any of your material which is currently omitted and which you feel ought to be included
3. give your name, department and address so that future forms for checking will get to you or your successor as easily as possible
4. return all the above information to me at the above address (using the self-adhesive label) IF POSSIBLE BY 20TH JULY, 1984.

The published directory will be printed on a Qume printer and reproduced using offset lithography to give a high quality finish. It is hoped the advance publicity will go out in mid September and that the directory will be available by the end of that month direct from the ASE.

The library of the Department of Education here has agreed to establish a collection of the materials referred to in the directory. This will provide an inspection service for teachers in the area, and will allow them to be specific in their requirements when ordering from suppliers. It is hoped that this facility will considerably increase the uptake of materials.

If your organization were able to encourage this initiative by giving to the library complimentary copies of the materials mentioned in the directory, it would be a great help and we would be pleased to credit such help in literature associated with the library collection.

Thank you for your help in all these matters.

Yours faithfully,
P.F. Gullett.

Appendix A.6

DATASHEET FOR PUBLISHER

NAME	of contact & department responsible for checking entries
ADDRESS	for NAME, especially if
TELEPHONE	different from the address for obtaining materials
CATALOGUE	of resources, available free, p & b etc.
MAILING LIST	for individual teachers / schools / PHYSDIR
DATE	
CHECK	please leave blank
VERIFY	

DATA SHEET FOR NEW ENTRY TO PHYSDIR

Key	Instructions
INDEX	please leave blank
SYLLABUS	blank
TITLE	CAPITALS
YEAR	19__ or pre 19__
DESCRIPTION	brief (< 72 characters) if not clear from TITL
AUTHOR	Smith, AB
FORMAT	see below
REFERENCE	company reference or ISBN
AGERANGE	5, 8, 11, 15, 18, 19, 16+
COST	£ --- free (loan)
PUBLISHER	name of originating company & division
DISTRIBUTOR	if different from PUBL
ADDRESS	of PUBL or DIST
REVIEW	in SSR or Phys. Educ.

Key to Format

 brochure, leaflet, CSW
 booklet, 35mm worksheet
 film, OHT, tape

 PP
 16mm standard/super8

A5, A4

b/w, colour

time

Appendix A.7

THE ASSOCIATION FOR SCIENCE EDUCATION

A Directory of Physics Resource Material

Materials for teachers produced by industrial and commercial organisations

Compiled and edited by
Peter Bullett
Department of Science Education
University of Warwick

Printed and published by:
The Association for Science Education
College Lane, Hatfield, Herts AL10 9AA

January 1985

© 1985 ISBN 0 86357 032 1

***** Contents *****

Foreword

Introduction

How to use the directory

Acknowledgements

Syllabus headings:

- 1.Mechanics
- 2.Heat
- 3.Molecular Properties
- 4.Waves
- 5.Light
- 6.Sound
- 7.AC: Generation, Transmission, Domestic Use and Safety
- 8.DC: Basic Principles, Instruments and Electrostatics
- 9.Electromagnetism
- 10.Electronics: Concepts, Applications and History
- 11.Electronics: Theoretical Basis
- 13.Electronics: Practical Work
- 14.Radioactivity: Atomic Physics and Detectors
- 15.Radioactivity: Power Production, Biological Effects and Safety
- 16.Energy: Resources and Conversion
- 17.Applications
- 18.Professional Materials

Publishers' names and addresses

Foreword:

This book is the result of an initiative taken by a member of the Association, Peter Bullett. With the aid of funds made available by the Institute of Physics he undertook a wide-ranging survey of materials published by industrial and commercial companies and professional organisations relevant to the teaching of physics in schools. He annotated and classified the material covered by the survey. It is here published in a form thought to be of considerable help to members of the Association: we welcome this book as another addition to the increasing range of materials currently published by the Association and - perhaps - as a model for a group of similar books.

It would not have been possible for this information to be collected together without the cooperation of the firms listed herein, financial support from the Institute of Physics and the technical advice and encouragement given by members of the staff of the University of Warwick. The Association is grateful to all those who have committed their time to this venture. Without the commitment and determination of Peter Bullett however, this project would not have reached publication. It is a pleasure to offer him the thanks and congratulations of the Association.

T.C.Swinfen
Chairman, Publications Committee

Introduction:

The purpose of the directory is to provide teachers of physics in school with a ready reference to sources of supporting material produced by industrial companies and professional bodies. Few teachers are in a position to make the commitment of time each year to order catalogues (when available) from nearly a hundred different organizations and scan them for the comparatively small number of entries relevant to physics.

To keep the number of listed items within manageable proportions, it has been necessary to exclude material produced by publishing houses or stocked by commercial film libraries unless directly commissioned by an industrial concern. Teachers will no doubt be aware of most of these excluded items through the advertizing of the publishers and libraries concerned. It is hoped that this 'preselection' of material, together with accurate details of the content and ordering process, will help to increase the uptake of the many excellent publications which are available, often at nominal cost or free of charge.

Although material has been solicited from as many sources as possible, the first edition of the directory makes no claim to comprehensive coverage of what is available. The Compiler would be pleased to hear from any producer of relevant material who would like it included in future editions of the directory and from any user who detects any omissions or errors.

Please write to:

The Compiler,
Physics Resources Directory,
Department of Science Education,
University of Warwick,
Westwood,
Coventry CV4 8EE

How to use the directory:

Materials are grouped under the eighteen broad syllabus divisions listed under 'Contents', in alphabetical order by title.

Information is given in the following order:

TITLE in block capitals
YEAR of publication or revision
DESCRIPTION if amplification of the title is necessary
AUTHOR(s)
FORMAT leaflet, book, video, film etc.
REFERENCE/ISBN manufacturer's reference or ISBN
AGE RANGE for which the material is suitable
COST free (loan), + p&p, s.a.e. etc.
PUBLISHER name of publishing organization
DISTRIBUTER if different from publisher
ADDRESS from which the material may be obtained

All prices include VAT unless stated otherwise. Every effort has been made to ensure that prices are correct when going to press (December, 1984), but it is suggested they be used only as a guide and should be confirmed with the publisher.

The suggested age ranges are those given by the publishers, or the recommendation of the Compiler where review copies have been supplied.

A separate list of publishers' names and addresses is given at the end of the directory to allow catalogues to be ordered easily.

Please note that all orders for materials (and enquiries as to their availability) should be made to the address given within the entry for the item in the main body of the directory.

Acknowledgements:

The Compiler gratefully acknowledges the assistance of the Institute of Physics in making funds available under its Small Grants Scheme towards the computing and preparation costs of the Directory and of the Association for Science Education in undertaking the publication of the completed directory.

He would also like to express his appreciation of the donation of much useful material by Beverley Madge of the Institute of Physics, the help and encouragement of his supervisor, Peter Screen of the Department of Science Education, University of Warwick and the invaluable technical assistance of Neil Coveney of the Computer Unit, University of Warwick in the preparation of the data-base.

MECHANICS

ACTING IN TURN 1974 History of the gear to present day;
Jackson,R; film 16mm colour 20min; 13+; free loan;
Shell UK Ltd., Shell Film Library, 25 The Burroughs,
Hendon, London NW4 4AT

EXPERIMENTS IN FORCE AND MOTION Trolleys and ticker-tape,
velocity, acceleration, Newton's Laws; Ritchie,B; film
16mm and video (beta and VHS) b/w 16min; teachers' notes;
Films for Science Teachers 9; teachers; film free loan,
video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom
Ltd., Audio Visual Library, Park Hall Trading Estate,
London SE21 8EL

FREE TO MOVE 1983 Friction and lubrication of machine parts;
film 16mm and video colour 17min; 13+; free loan;
Shell UK Ltd., Shell Film Library, 25 The Burroughs,
Hendon, London NW4 4AT

HOW AN AEROPLANE FLIES - BALANCE AND STABILITY 1975 Bringing
forces into balance (including animation); Armstrong,D;
film 16mm colour 11min; 13+; free loan; Shell UK Ltd.,
Shell Film Library, 25 The Burroughs, Hendon, London NW4
4AT

HOW AN AEROPLANE FLIES - LIFT AND WEIGHT 1975 Smoke tunnel
demonstrations and animations; Armstrong,D; film 16mm
colour 16min; 13+; free loan; Shell UK Ltd., Shell
Film Library, 25 The Burroughs, Hendon, London NW4 4AT

HOW AN AEROPLANE FLIES - THE CONTROLS AND THEIR EFFECT 1975
Shows the effect of ailerons, elevator and rudder;
Armstrong,D; film 16mm colour 17min; 13+; free loan;
Shell UK Ltd., Shell Film Library, 25 The Burroughs,
Hendon, London NW4 4AT

HOW AN AEROPLANE FLIES - THRUST AND DRAG 1975 Explains these
two forces acting on an aeroplane; Armstrong,D; film
16mm colour 11min; 13+; free loan; Shell UK Ltd.,
Shell Film Library, 25 The Burroughs, Hendon, London NW4
4AT

HYDRAULICS 1975 Pascal's Law is demonstrated and explained
with animations; Searle,A; film 16mm colour 14min; 13+;
free loan; Shell UK Ltd., Shell Film Library, 25 The
Burroughs, Hendon, London NW4 4AT

MECHANICAL HANDLING Summary of modern systems, conveyors,
battery trucks etc.; information sheet; 11+; free;
Electricity Council, Understanding Electricity, 30
Millbank, London SW1P 4RD

MODEL PETROL ENGINE 4 construction cards + instructions;
assembly cards; 11+; s.a.e.; Greater Manchester Museum
of Science and Industry, Manchester Air and Space Museum,
Castlefield, Liverpool Road, Manchester M3 4JP

MECHANICS (CONT.)

MOMENTUM AND COLLISION PROCESSES Newton III, collisions, momentum conservation, airgun experiment; Jardine, J; film 16mm and video (beta and VHS) b/w 18min; teachers' notes; Films for Science Teachers 10; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

PRINCIPLES OF LUBRICATION Reduction of friction by a free-flowing liquid; film 16mm and video (beta and VHS) colour 25min; 16+; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

THE PROBLEMS OF FLIGHT CONTROL IN EARLY AIRCRAFT George, AD; leaflet; Manchester Polytechnic occasional paper; 13+; £0.50 + postage; Greater Manchester Museum of Science and Industry, Manchester Air and Space Museum, Castlefield, Liverpool Road, Manchester M3 4JP

ROPES Data on British, Marine Towing and Blue Strand ropes; booklets; 1037, 1051/1, 1038; teachers; free; British Ropes Ltd., Anchor and Hope Lane, Charlton, London SE7 7SB

HEAT

BI-METAL FLAME FAILURE DEVICE OHT set and teachers' notes; Catalogue 34/6; 11-16; £4.00 + VAT; British Gas Educational Service, Room 707A, 326 High Holborn, London WC1V 7PT

DOMESTIC WET CENTRAL HEATING AND HOT WATER OHT set and teachers' notes; 11-16; £4.00 + VAT; British Gas Educational Service, 326 High Holborn, London WC1V 7PT

ELECTRO-HEAT Reviews methods of electrical heating; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

ELEMENTARY EXPERIMENTS IN HEAT RADIATION Transmission, black and polished surfaces, focusing; Tresise, Ms; film 16mm and video (beta and VHS) colour 11min; teachers' notes; Films for Science Teachers 7; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

THERMOSTATS Film 16mm colour 9min; 11-16; free loan; British Gas Film Library, Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

THERMOSTATS Shows construction of hydraulic and rod type; leaflet; 5a; 11-16+; single copy free with sae, (£1.30 for 20); Electrical Association for Women, 25 Foubert's Place, London W1V 2AL

HEAT (CONT.)

TRANSPERANCE OF HEAT Three films on Convection, Conduction and Radiation; film 16mm colour 30min total; 13-16; free loan; British Gas Film Library, Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

MOLECULAR PROPERTIES

AN APPROACH TO KINETIC THEORY Crystal growth, change of state, Brownian motion, diffusion; Sister St. Joan of Arc; film 16mm and video (beta and VHS) colour 19min; teachers' notes; Films for Science Teachers 12; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

CHANGE OF STATE Brownian motion, laws of thermodynamics and kinetic theory; film 16mm and video (beta and VHS) colour 20min; 13-16+; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

EQUILIBRIUM - THE LIMIT OF DISORDER 1971 Chemical reactions, electrolysis, free energy, application; Porter, Prof.G; video tape (VHS/Betamax) colour 25min; 16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

EXPERIMENTS WITH PLASTICS IN SCHOOL PHYSICS LABORATORIES 1978 Description of experiments to measure physical properties; booklet 18pp; Schools Publication 5; 16+; free; ICI (Plastics Division), Publicity Department, PO Box 6, Bessemer Road, Welwyn Garden City, Herts AL7 1HD

KINETIC ENERGY: INTRODUCTORY EXPERIMENTS Malvern energy kit, kinetic energy of trolleys, air-track; Grayson, K; film 16mm and video (beta and VHS) b/w 17min; teachers' notes; Films for Science Teachers 13; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

THE LAWS OF DISORDER - ENTROPY 1968 Royal Institution lecture - spontaneous changes and probability; Porter, Prof.G; video tape (VHS/Betamax) colour 22min; 16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

THE LAWS OF DISORDER - SECOND LAW OF THERMODYNAMICS 1969 Entropy and energy are discussed using steam engines; Porter, Prof.G; video tape (VHS/Betamax) colour 23min; 16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

MOLECULES AT WORK 1969 How a spontaneous change can be made to do work, reversibility; Porter, Prof.G; video tape (VHS/Betamax) colour 30min; 16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

MOLECULAR PROPERTIES (CONT.)

THE PHYSICS OF CHEMICAL STRUCTURE 1974 Booklet; 16+; £1.00 for 5 (cheque with order); Unilever PLC, Education Section, PO Box 68, Unilever House, London EC4P 4BQ

WHAT ARE PLASTICS? 1981 Concise, simple account; booklet 13pp; 16+; free; ICI (Plastics Division), Publicity Department, PO Box 6, Bessemer Road, Welwyn Garden City, Herts AL7 1HD

WAVES

ELECTRICAL OSCILLATIONS AND THE ELECTROMAGNETIC SPECTRUM High frequency transmission and reception, interference; Chaundy, D; film 16mm and video (beta and VHS) b/w 24min; teachers' notes; Films for Science Teachers 5; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

LIGHT

ABOUT 'KODAK' CAMERAS Describes camera manufacture and photography; booklet 12pp; CR1-12; 11-16+; free; Kodak Ltd., Customer Relations, PO Box 66, Station Road, Hemel Hempstead, Herts HP1 1JU

COLOUR Newton's investigations and history of colour photography; wallchart; T-912(H); 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Station Road, Hemel Hempstead, Herts HP1 1JU

EXPERIMENTS IN RAY OPTICS Pinhole camera, simple telescope, ray streaks, model eye; Dorling, G; film 16mm and video (beta and VHS) b/w 15min; teachers' notes; Films for Science Teachers 14; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

FLUORESCENCE 1975 Booklet; 16+; £1.00 for 5 (cheque with order); Unilever PLC, Education Section, PO Box 68, Unilever House, London EC4P 4BQ

HOW THE SCIENCE OF LIGHT LED US TO PHOTOGRAPHY History from primitive man to present day with experiments; wallchart; T-910(H); 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Station Road, Hemel Hempstead, Herts HP1 1JU

IMAGES AND IMAGINATION Photographic history from early efforts to space pictures; 12 colour and b/w reproductions 9" x 12"; CC7-1; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Hemel Hempstead, Herts HP1 1JU

INTRODUCING COLOUR 1975 Articles on technical, physiological, educational aspects; booklet 50pp; teachers; £1.00; The Society of Dyers and Colourists,

PO Box 244, Perkin House, 82 Grattan Road, Bradford BD1 2JB

PHOTOGRAPHY - HOW IT WORKS 1973 Animated introduction to basic principles and the camera; film 16mm colour 11min; 11-16+; free loan; Kodak Ltd., Random Film Library Ltd., 25 The Burroughs, Hendon, London NW4 4AT

THE PHOTON CONNECTION 1983 The 1982/3 IEE Faraday Lecture on light for communication; film 16mm 50min colour; video (beta and VHS) 33min + handbook; 13-16+; film hire £8.00 + VAT, video free loan; STC PLC, CFL Vision, Distribution Centre, Chalfont Grove, Gerrards Cross, Bucks SL9 8TN

SCANNING PHOTOMACROGRAPHY High definition pictures of tiny objects and creatures; 12 colour reproductions 9"*12"; CC7-6; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Hemel Hempstead, Herts HP1 1JU

SEEING THE INVISIBLE WORLD Photomicrographs of natural history and biological subjects; 14 colour reproductions 9"*12"; CR7-3; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Hemel Hempstead, Herts HP1 1JU

VISIBLE/INVISIBLE Photography used in scientific records of Schlieren, spectrography etc.; 12 colour reproductions 9"*12"; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Hemel Hempstead, Herts HP1 1JU

VISION 1980 Filmstrip/slides; Secondary Science; 11-16+; £6.30 - VAT; BBC Publications, 144/152 Bermondsey Street, London SE1 3TH

YOU PRESS THE BUTTON 1971 Shows how Kodak film is made and used; film 16mm colour 26min; 11-16+; free loan; Kodak Ltd., Random Film Library, 25 The Burroughs, Hendon, London NW4 4AT

AC: GENERATION, TRANSMISSION, DOMESTIC USE AND SAFETY

CENTENARY OF SERVICE History of electricity in the home over past 100 years; Byers, A; booklet 98pp; 11+; free (up to 5), £1.00 each thereafter; Electricity Council, Understanding Electricity, 30 Millbank, London SW1 4RD

ELECTRICITY SUPPLY AND THE ENVIRONMENT Principles of generation and transmission; Hawkins; booklet 64pp; 13-16+; free; Central Electricity Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

ELECTRICAL PROTECTION IN THE HOME Fuses and other devices; leaflet or wallchart; 15; 11-16+; single free with sae, (£1.30 for 20), wallchart £2.53; Electrical Association for Women, 25 Foubert's Place, London W1V 2AL

ELECTRICITY How it is made, people in the service, in the home, use; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

AC: GENERATION, TRANSMISSION, DOMESTIC USE AND SAFETY (CONT.)

ELECTRICITY Light, heat, motors, transmission, batteries, conductors, safety; filmstrip 35mm double frame + cassette; 8+; £2.40 (£1.60 without cassette); Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

ELECTRICITY FOR EVERYDAY LIVING Electricity principles, terminology, use of domestic appliances; booklet 84pp; 16+; £1.00, (£8.50 for 10, £24.00 for 30); Electrical Association for Women, 25 Foubert's Place, London W1V 2AL

ELECTRICITY IN YOUR HOME Behind the socket, to appliances, use of appliances; 3 filmstrips 35mm double frame; 8+; £1.00 each; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

ELECTRICITY THROUGH THE AGES Pictorial history of electricity supply; 12 wallcharts; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

ESSENTIAL ELECTRICITY - A USER'S GUIDE Electrical handbook for users; book; 16+; £6.95 (£7.70 with p.a.p.); Electrical Association for Women, 25 Foubert's Place, London W1V 2AL

HOW ELECTRICITY IS MADE Use of coal, oil or nuclear fuel to produce heat and electricity; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

HOW ELECTRICITY IS MADE AND TRANSMITTED Booklet 20pp; 13-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

LIGHTING History of electric lighting and different systems; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

LIGHTING AROUND YOUR HOME Electric circuitry and lighting; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

LIVING WITH ELECTRICITY Electrical safety in the home; filmstrip 35mm double frame + study notes; 11+; £1.60; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

LIVING WITH ELECTRICITY 1970 Discusses the dangers of the mis-use of electricity; film 16mm colour 16min; 11+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

A NON-TECHNICAL HANDBOOK ABOUT OVERHEAD TRANSMISSION LINES Jackson, G.B.; photocopy 32pp of an article; 13-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15

Newgate Street, London EC1A 7AU

ORGANISATION OF THE ELECTRICITY SUPPLY INDUSTRY Thumb-nail sketch of the industry in England and Wales; leaflet 4pp; 13+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

OSCILLOSCOPES AND SLOW AC Vrms/Vpeak, velocity of sound, ac in R,C,L, resonance, 3-phase ac; Foxcroft, GE; film 16mm and video (beta and VHS) b/w 23min; teachers' notes; Films for Science Teachers 16; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Ltd., Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

OUR WORLD OF ELECTRICITY Discovery, generation, use - complements film; filmstrip 35mm double frame + study notes; 11+; £1.60; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

PLAY SAFE Cartoon warning children of the dangers of electricity; leaflet 4pp; 8+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

PLAY SAFE 1978 Warns of dangers of playing near power lines and substations; film 16mm colour 11min; 8+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

POWER AROUND YOUR HOME The domestic ring; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

POWER PRODUCTION Distribution, boiler house, reactor, turbine, substation; 5 wallcharts; 11+; free; Central Electricity Generating Board, Understanding Electricity, Sudbury House, Newgate Street, London EC1A 7AU

POWER TO YOU Simple description of electricity distribution system; leaflet 2pp; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

POWER TO YOUR HOME Electricity transmission - suitable for 'O' and 'A'-level; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

POWER TO YOUR TELEVISION SET Electricity transmission - suitable for CSE; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

SAFE AS HOUSES Cartoon strip, telling children about electrical safety at home; leaflet 4pp; 8+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

SAFE AS HOUSES Complements the film of the same title; 3 wallcharts; 8+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

AC: GENERATION, TRANSMISSION, DOMESTIC USE AND SAFETY (CONT.)

SAFE AS HOUSES 1983 Deals with various aspects of electrical safety in the home; film 16mm colour 10min; 8+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

STANDARD PLUGS How to wire a plug; leaflet; 12; 11-16+; single copy free with sae, (£1.30 for 20); Electrical Association for Women, 25 Foubert's Place, London W1V 2AL

TRANSMISSION OF POWER Guide to electricity transmission in England and Wales; booklet 36pp; 13+; free; Central Electricity Generating Board, Understanding Electricity, Sudbury House, 15 Newgate Street, London EC1A 7AU

132 000 VOLT TRANSMISSION LINES History of transmission towers with specifications; booklet 12pp; 13-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

DC: BASIC PRINCIPLES, INSTRUMENTS AND ELECTROSTATICS

BASIC ELECTRICAL PRINCIPLES SERIES Complement the films in the similarly named series; 8 filmstrips 35mm single frame, study notes; 8+; £1.60 each; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

BASIC ELECTRICAL PRINCIPLES SERIES Principles are related to familiar applications and appliances; 8 short films 16mm colour on one reel, total 39min; 11+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

ELECTRICITY Introduction to learning about electricity; Fitzpatrick,J; booklet 32pp + teacher's notes 4pp; 5-8; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1 4RD

ELECTROSTATICS - A MODERN APPROACH Conservation of charge, induction, E-fields and capacitance; Wenham,T and Harrap,M; film 16mm and video (beta and VHS) b/w 14min; teachers' notes; Films for Science Teachers 2; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

HOW TO READ YOUR METER Digital and dial meters; leaflet 4pp; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

THE MODERN BATTERY How a chemical reaction produces energy in a car battery; video tape (beta, VHS, U-matic, Phillips) colour 21min; CT 112; 13-16+; £110 + VAT; Road Transport Industry Training Board, Information Centre, Capitol House, Empire Way, Wembley, Middlesex HA9 0NG

DC: BASIC PRINCIPLES, INSTRUMENTS AND ELECTROSTATICS (CONT.)

UNDERSTANDING YOUR WORLD OF ELECTRICITY A young person's guide to electricity; booklet 30pp; 8+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

WHAT IS ELECTRICITY? Lecture on the basics of electricity; Churchman, Dr. T; film 16mm colour 27min; 13+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

THE WORCESTER CIRCUIT BOARD Demonstrations using this board; Wenham, T; film 16mm and video (beta and VHS) b/w 16min; teachers' notes; Films for Science Teachers 8; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

ELECTROMAGNETISM

THE CIRCLE OF MAGNETISM 1971 Magnetic and electrical circuits presented entertainingly; Laithwaite, Prof. E; video tape (VHS/Betamax) colour 21min; 13-16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

DISCOVERING ELECTRICITY 1975 Shows some of Faraday's actual models in historical account; Churchman, Dr. T; film 16mm colour 40min; 13+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

THE ELECTRIC WAVE The work of Michael Faraday in 1831 and modern generation; leaflet 6pp; 13+; free; Central Electricity Generating Board, Understanding Electricity, Sudbury House, 15 Newgate Street, London EC1A 7AU

THE ELECTROMAGNETIC KIT Demonstration of experiments with the Westminster kit; Osborne, J; film 16mm and video (beta and VHS) b/w 13min; teachers' notes; Films for Science Teachers 4; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

THE FORCES OF INDUCTION 1969 The theory and applications of electro-magnetism, travelling waves; Laithwaite, Prof. E; video tape (VHS/Betamax) colour 19min; 13-16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

INDUCTION HEATING Principles and applications to metal heating in industry; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

MOTORS BIG AND SMALL 1971 Demonstrates magnetic and electro-magnetic motors, applications; Laithwaite, Prof. E; video tape (VHS/Betamax) colour 21min; 16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15

Beaconsfield Road, London NW10 2LE

SHAPING THINGS TO COME 1972 How shape and size affects design of electro-magnetic machines; Laithwaite, Prof.E; video tape (VHS/Betamax) colour 24min; 11-16+; £12.00 + VAT; ICI, Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE

ELECTRONICS: CONCEPTS, APPLICATIONS AND HISTORY

CHALLENGE OF THE CHIP History of computing before 1947 and succeeding developments; booklet 36pp; ISBN 0 11 290330 4; 11+; £1.50; HMSO; 258 Broad Street, Birmingham B1 2HE

COMPUTING APPLICATIONS Data processing applications and case studies; project package; 11-16+; free; IBM, Southern Science and Technology Forum, PO Box 4, Lymington, Hants SO4 9YF

COMPUTING CONCEPTS Beginners' introduction and technological development; project package; 11-16+; free; IBM, Southern Science and Technology Forum, PO Box 4, Lymington, Hants SO4 9YF

MICROELECTRONICS - THE NEW TECHNOLOGY Survey and applications; booklet 24pp; 13-16+; free; Department of Trade and Industry, MAP Information Centre, Room 514, 29 Bressenden Place, London SW1E 5DT

MICROELECTRONICS - THE OPTIONS 1979 Survey of alternative choices for applications; booklet 16pp; 13-16+; free; Department of Trade and Industry, MAP Information Centre, Room 514, 29 Bressenden Place, London SW1E 5DT

ELECTRONICS: THEORETICAL BASIS

ELECTRICAL/ELECTRONIC GRAPHICAL SYMBOLS FOR SCHOOLS AND COLLEGES; A selection from BS 3939 for teachers and students; booklet 20pp and A1 wallchart (not available separately); PD 7303; 16+; £6.00 + VAT; British Standards Institution, Linford Wood, Milton Keynes, MK4 6LE

MICROPROCESSORS - A SHORT INTRODUCTION Knowledge, expertise and facilities for a computer-based project; Morgan,M; book 96pp; ISBN 0 11 983253 4; 11+; £5.00; HMSO; 258 Broad Street, Birmingham B1 2HE

SEMI-CONDUCTION AND THE TRANSISTOR Properties, p-n junction, rectifier, transistor, amplifier; Osborne,J; film 16mm and video (beta and VHS) colour 18min; teachers' notes; Films for Science Teachers 20; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Ltd., Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

ELECTRONICS: PRACTICAL WORK

MICROELECTRONICS - PRACTICAL APPROACHES FOR SCHOOLS AND COLLEGES Trotter,M and Bevis,G; handbook 96pp; BT26;

ISBN 0 86165 037 9; 16+; £2.75; British Petroleum, BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 7EH

RADIOACTIVITY: ATOMIC PHYSICS AND DETECTORS

AN APPROACH TO THE ELECTRON Thermionic emission, cathode rays, leading to atomic structure; Llowarch,W; film 16mm and video (beta and VHS) colour 14min; teachers' notes; Films for Science Teachers 6; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

THE ATOM 1983 Protons, neutrons, electrons, nucleus, nuclides; filmstrip 35mm, 36 single frames; Z1; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

ATOMIC MASS 1983 amu, mass spectrometry, ram of elements with several isotopes; filmstrip 35mm, 36 single frames; Z2; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

ATOMIC STRUCTURE Deflection tubes, alpha/beta particles, energy levels; Mander,M; film 16mm and video (beta and VHS) colour 15min; teachers' notes; Films for Science Teachers 26; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Ltd., Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

ATOMS AT WORK 1983 Describes fission and fusion; booklet; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

THE CHART OF THE NUCLIDES 1983 Ascertains abundance, modes of decay, energies, natural series; filmstrip 35mm, 36 single frames; Z7; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

FURTHER EXPERIMENTS IN RADIOACTIVITY Absorption, deflection and randomness of radiations, half-life; Lewis,J; film 16mm and video (beta and VHS) b/w 25min; teachers' notes; Films for Science Teachers 11; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Company Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

GAS-FILLED DETECTORS 1983 Ionisation chambers, proportional counters, geiger counters; filmstrip 35mm, 36 single frames; Z8; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

INTRODUCTION TO RADIOACTIVITY Radiations, Geiger tube, gold leaf electroscope; Lewis,J; film 16mm and video (beta and VHS) b/w 18min; teachers' notes; Films for Science Teachers 3; teachers; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

RADIOACTIVITY: ATOMIC PHYSICS AND DETECTORS (CONT.)

NUCLEAR ENERGY 1983 Einstein's mass equation, mass defects, fission, fusion; filmstrip 35mm, 36 single frames; Z5; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

NUCLEAR FISSION AND CRITICALITY 1983 Spontaneous/induced fission, products, chain reactions, reactors; filmstrip 35mm, 36 single frames; Z12; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd, 143 Chatham Road, London SW11 6SR

NUCLEAR FUSION - POWER FOR THE NEXT CENTURY 1983 Describes the theory and progress of nuclear fusion; leaflet; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

NUCLEAR FUSION RESEARCH 1983 Plasmas (Lawson criterion), inertial and magnetic confinement; filmstrip 35mm, 36 single frames; Z40; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd, 143 Chatham Road, London SW11 6SR

RADIATION Complements leaflet of same title; wallchart; 16+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

RADIOACTIVITY 1983 Stable and radioactive nuclides, alpha, beta, gamma, half-life; filmstrip 35mm, 36 single frames; Z3; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

SOLID STATE DETECTORS AND NEUTRON DETECTORS 1983 Energy resolution, scintillation counters, photographic films; filmstrip 35mm, 36 single frames; Z9; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

RADIOACTIVITY: POWER PRODUCTION, BIOLOGICAL EFFECTS AND SAFETY

ACCELERATORS 1983 Charged particle, high voltage, cyclic accelerators; filmstrip 35mm, 36 single frames; Z39; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd, 143 Chatham Road, London SW11 6SR

CALDER HALL Its role in UK electricity generation; booklet 16pp; 11-16+; free; British Nuclear Fuels, Information Services, Risley, Warrington WA3 6AS

CHAPELCROSS Its history, development and impact; booklet 16pp; 11-16+; free; British Nuclear Fuels, Information Services, Risley, Warrington WA3 6AS

THE EFFECTS AND CONTROL OF RADIATION 1982 Describes sources and biological effects; booklet 24pp; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

THE FACTS ABOUT NUCLEAR ENERGY A guide to development and activities in Britain; booklet 16pp; 13+; free; Electricity Council, Understanding Electricity, 30

Millbank, London SW1P 4RD

THE FAST REACTORS - THE POTENTIAL FOR POWER 1984 Explains its development in non-technical terms; leaflet 10pp; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

HARTLEPOOL NUCLEAR POWER STATION Outlines AGR concept; leaflet; 11-16+; free; National Nuclear Corporation Ltd., Information Services Department, Booths Hall, Knutsford, Cheshire WA16 8QZ

HEYSHAM 2 AND TORNESS Describes these AGR stations; booklet; 11-16+; free; National Nuclear Corporation Ltd., Information Services Department, Booths Hall, Knutsford, Cheshire WA16 8QZ

HUNTERSTON 'A' NUCLEAR POWER STATION Explains the chain reaction and Magnox reactors; leaflet; 11-16+; free; South of Scotland Electricity Board, Public Relations Department, Cathcart House, Glasgow G44 4BE

HUNTERSTON 'B' NUCLEAR POWER STATION Explains AGR with main design characteristics; leaflet; 11-16+; free; South of Scotland Electricity Board, Public Relations Department, Cathcart House, Glasgow G44 4BE

LIFE WITH NUCLEAR ENERGY How nuclear electricity is produced and why it is needed; filmstrip 35mm double frame + cassette; 11+; £2.40 (£1.60 without cassette); Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

LIFE WITH NUCLEAR ENERGY Production and need for nuclear energy; wallchart; 13+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

THE NEED FOR NUCLEAR POWER Intended for schools; leaflet; 11-16+; free; The Electricity Council, Public Relations Department, 30 Millbank, London SW1P 4RD

NUCLEAR ENERGY - A PROGRESS REPORT A talk by Glyn England, Chairman; leaflet; 11-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

NUCLEAR ENERGY IN BRITAIN 1981 Introduction to generation, power stations, fuel and safety; booklet 36pp; ISBN 0 11 701011 1; 11-16+; £3.15; HMSO, 258 Broad Street, Birmingham B1 2HE

NUCLEAR ENERGY IN THE UK booklet; Fact Sheet 6; 11-16+; free; Department of Energy, The Library, Thames House South, Millbank, London SW1P 4QJ

NUCLEAR KNOW HOW Cartoon in which a neutron tells the story of nuclear power; booklet 20pp; 13+; free; Central Electricity Generating Board, Understanding Electricity, Sudbury House, 15 Newgate Street, London EC1A 7AU

RADIOACTIVITY: POWER PRODUCTION, BIOLOGICAL EFFECTS AND SAFETY (CONT.)

NUCLEAR POWER REACTORS 1984 Describes main types of nuclear reactor in UK and world; booklet 20pp; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

NUCLEAR POWER...ITS INTEGRATION INTO A LARGE UTILITY Describes the absorption of nuclear alongside other techniques; booklet 28pp; 11-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

NUCLEAR REACTIONS 1983 Equations, charged particle and neutron reactions, cross-sections; filmstrip 35mm, 36 single frames; Z6; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

NUCLEAR REACTORS 1983 Components, fuel, moderator, control rods, coolant, reactor types; filmstrip 35mm, 36 single frames; Z37; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd, 143 Chatham Road, London SW11 6SR

NUCLEAR WASTE DISPOSAL How it arises and is dealt with; booklet; 11-16+; free; British Nuclear Forum, 1 St. Albans Street, London, SW1Y 4SL

PLUTONIUM 1984 Describes its creation, properties, handling and use in reactors; leaflet 5pp; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

PRODUCTION OF NUCLEAR POWER Describes the need, nuclear fission, fuel cycle and radiation; brochure 12pp; 11-16+; free; British Nuclear Fuels, Information Services, Risley, Warrington WA3 6AS

RADIATION - ITS ORIGIN AND EFFECT 1981 Nature, types, effect on public, dose-limits etc.; leaflet 4pp; 13-16+; free; Central Electricity Generating Board, Dept. of Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

RADIATION AND CONTAMINATION 1983 External and internal hazards, film badges, containment; filmstrip 35mm, 36 single frames; Z11; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

RADIOLOGICAL PROTECTION 1983 Effects on the body, definition of units; filmstrip 35mm, 36 single frames; Z10; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd., 143 Chatham Road, London SW11 6SR

RESEARCH WITH REACTORS 1983 Use of reactors in a variety of experiments; filmstrip 35mm, 36 single frames; Z38; 16+; £15.60 + VAT; UKAEA, Slide Centre Ltd, 143 Chatham Road, London SW11 6SR

RADIOACTIVITY: POWER PRODUCTION, BIOLOGICAL EFFECTS AND SAFETY (CONT.)

UNDERSTANDING NUCLEAR ENERGY Power station with its reactor and transmission of electricity; wallchart; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

USING RADIOACTIVITY 1984 Describes medical aspects of radioactivity; leaflet 8pp; 11-16+; free; UKAEA, Information Services Branch, 11 Charles II Street, London SW1Y 4QP

THE VITRIFICATION OF HIGHLY-ACTIVE LIQUID WASTE Explains how wastes are solidified in glass for long-term storage; leaflet; 13-16+; free; British Nuclear Fuels Ltd., Information Services, Risley, Warrington WA3 6AS

WORKING WITH RADIATION Radiation, biological effects, control and precautions; brochure 36pp; 13-16+; free; British Nuclear Fuels, Information Services, Risley, Warrington WA3 6AS

WORLD NUCLEAR FUEL CYCLE World map showing nature and scale of operations; wallchart; 11-16+; free; British Nuclear Fuels Ltd., Information Services, Risley, Warrington WA3 6AS

ENERGY: RESOURCES AND CONVERSION

BRITAIN'S ENERGY RESOURCES Introduction to consumption of oil, gas, coal, electricity etc.; booklet 32pp; COI reference pamphlet 166, ISBN 0 11 7010421; 11+; £2.40; HMSO; 258 Broad Street, Birmingham B1 2HE

CHILDREN AND ENERGY resource packs (booklets, teachers' leaflet, picture and workcard); K1/1-4; 8-16; £2.75 each, £10.00 for 4; British Petroleum, BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 7EH

CONSERVATION OF FUEL AND ENERGY Audio-visual pack reviewing current sources of energy; 45 slides, cassette tape, transcript and teachers' notes; Catalogue 55; 13-16+; £6.00 + VAT; British Gas Education Service, Room 707A, 326 High Holborn, London WC1V 7PT

ENERGETICALLY YOURS Cartoon outline of Man's need and use of energy historically; Searle, R; film 16mm and video (beta and VHS) colour 14min; Films for Science Teachers; 11-16; film free loan, video £11.75 + VAT; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

ENERGY CONVERTED 1980 Filmstrip/slides; Secondary Science; 11-16+; £6.30 + VAT; BBC Publications, 144/152 Bermondsey Street, London SE1 3TH

ENERGY FOR TOMORROW 1982 General interest pack, outlining role of science and technology; filmstrip 35mm, 36 single frames; Z41; 16+; £7.25 + VAT; UKAEA, Slide

Centre Ltd, 143 Chatham Road, London SW11 6SR

ENERGY IN PERSPECTIVE Development of nuclear, solar, geothermal and tidal energy; film 16mm and video, colour 25min; 16+; free loan; British Petroleum, Film Library, 15 Beaconsfield Road, London NW10 2LE

ENERGY WITHIN REASON Discusses vital issues of energy supply, use, waste and reserves; film 16mm and video, colour 26min; 16+; free loan; British Petroleum, Film Library, 15 Beaconsfield Road, London NW10 2LE

GLOBAL ENERGY RESOURCES Provides a simple approach to the topic; Whatley, B.W.; handbook; BT8, ISBN 0 901918 383; 8-16; £1.25; British Petroleum, BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 7EH

GLOBAL ENERGY RESOURCES Shows a section of the Earth with sources of energy; wallchart; W70; 8-16; £1.25; British Petroleum, BP Educational Service, PO Box 5, Wetherby, West Yorkshire LS23 7EH

HEAT RECOVERY IN INDUSTRY Methods so valuable for saving energy; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

THE SEARCH FOR RENEWABLE ENERGY SOURCES Describes research into wind, wave, tidal and geothermal energy; leaflet; 11-16+; free; Central Electricity Generating Board, Dept. Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

SOLAR, WIND AND WATER POWER Randle, J & D; 5 duplicated A4 sheets on each; 5-16+; £0.30 each; The National Centre for Alternative Technology, Machynlleth, Powys, Wales

SOURCES OF ENERGY 1980 Filmstrip/slides; Secondary Science; 11-16+; £6.30 + VAT; BBC Publications, 144/152 Bermondsey Street, London SE1 3TH

WATERWHEELS Outlines principles of energy extraction; leaflet; teachers; large s.a.e; Greater Manchester Museum of Science and Industry, Manchester Air and Space Museum, Education Service, Liverpool Road, Manchester M3 4JP

WAVE ENERGY An interim statement on the potential and prospects; Dawson, JK; book 98pp; ISBN 0 11 410774 2; 11-16+; £5.00; HMSO, 258 Broad Street, Birmingham B1 2HE

WIND TURBINE FOR RICHBOROUGH 1983 Special report, sketching background and issues; leaflet 4pp; 13-16+; free; Central Electricity Generating Board, Dept. of Information and Public Affairs, Sudbury House, 15 Newgate Street, London EC1A 7AU

ENERGY: RESOURCES AND CONVERSION (CONT.)

WINDMILLS Outlines principles of energy extraction; leaflet; teachers; large s.a.e; Greater Manchester Museum of Science and Industry, Manchester Air and Space Museum, Education Service, Liverpool Road, Manchester M3 4JP

APPLICATIONS

ADVANCE INTO THE UNKNOWN Research necessary for space flights with Saturn-type rocket; film 16mm and video (beta and VHS) colour 24min; 13-16+ film free loan; Esso Petroleum Co. Ltd., Viscom Ltd., Audio Visual Library, Park Hall Trading Estate, London SE21 8EL

AEROSOL ABC 1975 Account of aerosol manufacture; Roberts, D.J.; booklet 48pp; 11-16+; free; British Aerosol Manufacturers' Association, Alembic House, 93 Albert Embankment, London SE1 7TU

AIR CONDITIONING How it treats air and the systems used; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

APPLICATIONS FOR SEMI-CONDUCTOR TECHNOLOGY (CLAYTON REPORT) The Clayton report on 'chips'; booklet 32pp; ISBN 0 11 630807 9; 11+; 85p; HMSO; 258 Broad Street, Birmingham B1 2HE

APPLICATIONS OF INFORMATION TECHNOLOGY 1984 Illustrate different areas of applications of information technology; IBM/MEP; 6 wallcharts; 8-13; £3.00; IBM, Southern Science Technology Forum, Schools and Colleges Information Service, PO Box 4, Lymington, Hants

APPLICATIONS OF SCIENCE IN THE GAS INDUSTRY Resource book, British Gas Midlands Research Station; book 50pp + OHP transparency masters; Catalogue 51; 13-16+; £2.25, £8.00 (for 5 without OHP material); British Gas Education Service, Room 707A, 326 High Holborn, London WC1V 7PT

THE ATMOSPHERIC GAS ENGINE leaflet; teachers; large s.a.e; Greater Manchester Museum of Science and Industry, Manchester Air and Space Museum, Education Service, Liverpool Road, Manchester M3 4JP

BAROMETERS 1978 Illustrated scientific history, giving principles; Thoday, AG; booklet 40pp; ISBN 0 11 290255 3; 11-16+; £1.50; HMSO, 258 Broad Street, Birmingham B1 2HE

BASIC ENGINE PRINCIPLES 4-stroke, 2-stroke and rotary engines; video tape (beta, VHS, U-matic, Phillips) 16min; CT 103; 13-16+; £90.0 + VAT; Road Transport Industry Training Board, Information Centre, Capitol House, Empire Way, Wembley, Middlesex HA9 0NG

APPLICATIONS (CONT.)

BIBLIOGRAPHY ON MICROELECTRONIC APPLICATIONS 1981 Booklet 17pp; teachers; free; Department of Trade and Industry, MAP Information Centre, Room 514, 29 Bressenden Place, London SW1E 5DT

BRITAIN'S AEROSPACE INDUSTRY Aircraft, weapons, space, helicopters, hovercraft; booklet 50pp; ISBN 0 11 701 0308 ; 11+; £3.95; HMSO; 258 Broad Street, Birmingham B1 2HE

CLOSED CIRCUIT TELEVISION Tells the story of this technique in industry and commerce; information sheet; 11+; free; Electricity Council, Understanding Electricity, 30 Millbank, London SW1P 4RD

DIESEL 1973 Shows the operation and variety of diesel engines; Jackson,R; film 16mm colour 20min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

DISCOVERING RAILWAYS Resource pack with discovery cards, models and time chart; Lloyd,G; audio-cassette, slides and packs; 8-13; £22.90 (picture pack, wallchart, £3.95, 32 discovery cards £5.95); British Rail, International Teaching Resource Centre, PO Box 10, Wetherby, LS23 7EL

ELECTRIC VEHICLES 1976 The benefits which could be obtained from their further use; film 16mm colour 20min; 13+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

ENGINEERING - NORTH SEA 1976 Development and technology of platform and pipe-line construction; film 16mm and video colour 27min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

FORMING OF METALS 1957 Shows variety of forming methods on various scales; de Normanville,P; film 16mm colour 28min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

FUEL INTO POWER 4-stroke (spark ignition and diesel), 2-stroke, gas turbine; 4 wallcharts; 11+; free; Shell UK Ltd., Shell Education Service, Shell-Mex House, Strand, London WC2R 0DX

THE GASS BOOK Gas applications for school science; A4 book 300pp; Catalogue 60; 13-16+; £2.95; British Gas Education Service, with ASE; Room 707A, 326 High Holborn, London WC1V 7PT

HEAT PUMPS - THE ENERGY SAVERS 1980 Explains why they are chosen for various situations; film 16mm colour 18min; 13+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

APPLICATIONS (CONT.)

HIGH CONDUCTIVITY COPPERS 1981 Properties and applications; booklet 34pp; TN 29; teachers and 16+; £1.00; Copper Development Association, Orchard House, Mutton Lane, Potters Bar, Herts EN6 3AP

HIGH SPEED FLIGHT 1960 Shows the behaviour of airflow and how designers solve problems; Segaller,D; film 16mm and video colour 21min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

A HISTORY OF THE TELEPHONE 1980 Film 16mm and video (beta, VHS, U-matic) colour, 20min; 11-16+; free loan; British Telecom, Film Library, 25 The Burroughs, Hendon, London NW4 4AT

HOBSONS COMPUTING CASEBOOK 1984 Young graduates at work in computing companies; book A4; ISBN 0 86021 551 2; 16+; £4.95; Hobsons Ltd., Bateman Street, Cambridge CB2 1LZ

HOBSONS ENGINEERING CASEBOOK 1980 Problems solved by young engineers in industry, showing principles; book 94pp; ISBN 0 86021 315 3; 13-16+; £8.00; CRAC, Hobsons Ltd., Bateman Street, Cambridge CB2 1LZ

HOW THE MOTOR CAR WORKS - CARBURETTOR 1977 Experiments and animated diagrams; Seager,G; film 16mm and video colour 12min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

HOW THE MOTOR CAR WORKS - ENGINE LUBRICATION 1968 Shows role of oil, in a transparent engine system; Heckford,M; film 16mm and video colour 10min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

HOW THE MOTOR CAR WORKS - THE ENGINE 1967 4-stroke sequence illustrated in a toughened glass cylinder; Armstrong,D; film 16mm and video colour 17min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

IGNITION - BASIC PRINCIPLES The ignition system in a car, distributor, automatic advance; video tape (beta, VHS, U-matic, Phillips) colour 23min; CT 107; 13-16+; £110 + VAT; Road Transport Industry Training Board, Information Centre, Capitol House, Empire Way, Wembley, Middlesex HA9 0NG

INFRA RED HEATING 1979 Applications in industry of short, medium and long i-r; 3 short films 16mm colour 11min; 13+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

MAKING PICTURES MOVE History of moving pictures with experiments; wallchart; T-911(H); 11-16+; 60p; Kodak Ltd., Customer Relations, PO Box 66, Station Road,

Hemel Hempstead, Herts HP1 1JU

MAKING THINGS FROM PLASTICS 1975 Shows methods of forming plastics; leaflet 2pp; G70; 16+; free; ICI (Plastics Division), Publicity Department, PO Box 6, Bessemer Road, Welwyn Garden City, Herts AL7 1HD

MATERIALS IN ACTION: CONCORDE leaflet 6pp; 16+; free; The Institution of Metallurgists, The Education Officer, PO Box 471, 1 Carlton House Terrace, London SW1Y 5BE

MATERIALS IN ACTION: SUPER-PLASTIC ALLOYS Shows the variety of artefacts made from these alloys; leaflet 6pp; 16+; free; The Institution of Metallurgists, The Education Officer, PO Box 471, 1 Carlton House Terrace, London SW1Y 5BE

MICROELECTRONICS AT WORK 1984 24 leaflets illustrating commercial and industrial applications; leaflet 4pp; 13-16+; free; Department of Trade and Industry, MAP Information Centre, Room 514, 29 Bressenden Place, London SW1E 5DT

MICROWAVE COOKING - AN EVERYDAY SUCCESS 1979 Explains what it is, how it works, where it can be used; film 16mm colour 18min; 11+; free loan; Electricity Council, Understanding Electricity Film Service, 15 Beaconsfield Road, London NW10 2LE

THE MODERN SPARKING PLUG Different plug types and their temperature range; video tape (beta, VHS, U-matic, Phillips) colour 19min; CT 105; 13-16+; £110 + VAT; Road Transport Industry Training Board, Information Centre, Capitol House, Empire Way, Wembley, Middlesex HA9 0NG

THE MOTOR CAR Shows the principles of motor car operation; 3 wallcharts; 13+; free; Shell UK Ltd., Shell Education Service, Shell-Mex House, Strand, London WC2R 0DX

ON THE RIGHT TRACK 1981 Describes an advanced radar system for air traffic control; film 16mm colour 11min; 16+; free loan; Cossor Electronics Ltd., Publicity Manager, The Pinnacles, Harlow, Essex CM19 5BB

THE OTTO FOUR-STROKE ENGINE Leaflet; teachers; large s.a.e; Greater Manchester Museum of Science and Industry, Manchester Air and Space Museum, Education Service, Liverpool Road, Manchester M3 4JP

PHOTOGRAPHY - VITAL TOOL IN SCIENCE Shows how events which are difficult to detect can be captured; 12 colour and b/w reproductions 9" x 12"; CR7-900; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Station Road, Hemel Hempstead, Herts HP1 1JU

PHYSICS PRINCIPLES AT WORK Physics used to solve industrial problems (with practicals); Barclay, A and Gibbons, A; A4 handbook 100pp; BT32; ISBN 0 86165 078 6; 16+; £3.75; British Petroleum, BP Educational Service, PO Box 5,

Wetherby, West Yorkshire LS23 7EH

SCIENTIFIC SOLUTIONS Industrial problem solving for 14-18 year olds; film 16mm colour 25min; 13-16+; free loan; British Gas Film Library, Viscom Ltd., Park Hall Trading Estate, London SE21 8EL

TALKING MACHINES 1982 Illustrated scientific history of phonographs 1877 to 1914; Chew, VK; booklet 82pp; ISBN 0 11 290329 0; 11-16+; £2.95; HMSO, 258 Broad Street, Birmingham B1 2HE

THE TELEPHONE EXCHANGE 1982 History and operation; film 16mm and video (beta, VHS, U-matic) colour, 22min; 11-16+; free loan; British Telecom, Film Library, 25 The Burroughs, Hendon, London NW4 4AT

THE TWO-STROKE 1977 Animated account of the operation of the engine; Mills, P; film 16mm and video colour 16min; 13+; free loan; Shell UK Ltd., Shell Film Library, 25 The Burroughs, Hendon, London NW4 4AT

THE UNSEEN WORLD OF PHOTOGRAPHY Supplement to 'Photography - vital tool in science'; 12 colour and b/w reproductions 9" x 12"; CR7-902; 11-16+; £0.60; Kodak Ltd., Customer Relations, PO Box 66, Station Road, Hemel Hempstead, Herts HP1 1JU

VOICES IN ORBIT 1972 Describes INTELSAT IV and how communications are made; film 16mm and video (beta, VHS, U-matic) colour, 24min; 13-16+; free loan; British Telecom, Film Library, 25 The Burroughs, Hendon, London NW4 4AT

WORTH HOW MANY WORDS 1969 Time-lapse photography speeds up and slows down many events; film 16mm colour 8min; 11-16+; free loan; Kodak Ltd., Random Film Library Ltd., 25 The Burroughs, Hendon, London NW4 4AT

PROFESSIONAL MATERIALS

AN INVESTIGATION INTO ENERGY EDUCATION IN SECONDARY SCHOOLS 1981 Research report; teachers; £3.00; Electricity Consumers' Council, Brook House, 2-16 Torrington Place, London WC1E 7LL

MANAGEMENT IN SCHOOL SCIENCE DEPARTMENTS 4 in-service modules for teachers Roles, Meetings, Time and Staff; tutors' guide, OHP transparency masters and handouts; Catalogue 70-73; teachers; £6.00 each + 13p VAT on audio tape for 'Time'; British Gas Educational Service, Room 707A, 326 High Holborn, London WC1V 7PT

MICRO-ELECTRONICS 1980 A guide to information sources; booklet 20pp; teachers; free; Understanding British Industry, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QE

PROFESSIONAL MATERIALS (CONT.)

SI THE INTERNATIONAL SYSTEM OF UNITS 1982 Approved translation of the standard French text; booklet 64pp; ISBN 0 11 480050 2; teachers; £3.95; HMSO, 258 Broad Street, Birmingham B1 2HE

TEACHING MATERIALS 1984 A directory of materials available from industry and commerce; booklet 72pp; teachers; free to teachers; £2.00; Understanding British Industry, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QE

British Aerosol Manufacturers'
Association,
Alembic House,
93 Albert Embankment,
London SE1 7TU
01-582 1115

British Gas Education Service,
Room 707A
326 High Holborn,
London WC1V 7PT
01-242 0789 Ex3452

British Nuclear Fuels PLC,
Information Services,
Risley,
Warrington WA3 6AS
Warrington 35953 Ex2241

British Petroleum Film Library,
15 Beaconsfield Road,
London NW10 2LE
01-451 1127

British Ropes Ltd.,
Publicity Department,
Anchor and Hope Lane,
Charlton,
London SE7 7SB
01-858 6121

British Telecom Film Library,
25 The Burroughs,
Hendon, London NW4 4AT
01-936 2000

Copper Development Association,
Orchard House,
Mutton Lane,
Potters Bar,
Herts EN6 3AP
Potters Bar (0707) 50711

CEGB,
Press and Publicity Office,
Sudbury House,
15 Newgate Street,
London EC1A 7AU
01-634 6454

BBC Publications,
144/152 Bermondsey Street,
London SE1 3TH
01-407 6961 Ex248

British Gas Film Library,
Viscom Ltd.,
Park Hall Trading Estate,
London SE21 8EL
01-761 3035/8

British Petroleum,
Educational Service,
Britannic House,
Moor Lane, London EC2Y 9BU
01-920 6636

British Rail,
Public Affairs Manager,
BR Eastern Region,
Room M45,
York YO1 1HT
York (0904) 63022 Ex3021/2

British Standards Institution,
Education Section,
2 Park Street,
London W1A 2BS
01-629 9000

Central Electricity Generating Board,
Dept. Information and Public Affairs,
Sudbury House,
15 Newgate Street,
London EC1A 7AU
01-634 6454

Cossor Electronics Ltd.,
Publicity Manager,
The Pinnacles,
Harlow,
Essex CM19 5BB
Harlow (0279) 26862

CRAC, Hobsons Ltd.,
Bateman Street,
Cambridge CB2 1LZ
Cambridge (0223) 354551

Department of Energy,
The Library,
Thames House South,
Millbank,
London SW1P 4QJ
01-211 3394

Department of Trade and Industry,
Ashdown House,
123 Victoria Street,
London SW1E 6RB
01-212 8792

Electricity Consumers' Council,
2-16 Torrington Place,
London WC1E 7LL
01-636 5703

Electricity Council,
Understanding Electricity
Film Service,
15 Beaconsfield Road,
London NW10 2LE
01-451 1127

Esso Petroleum Co. Ltd.,
Viscom Ltd.,
Audio Visual Library,
Park Hall Trading Estate,
London SE21 8EL
01-761 3035/8

Greater Manchester Museum
of Science and Industry,
Manchester Air and Space Museum,
Castlefield,
Liverpool Road,
Manchester M3 4JP
061-832 2244

The Institution of Metallurgists,
The Education Officer,
PO Box 471,
1 Carlton House Terrace,
London SW1 5BE
01-839 1963

ICI Plastics Division,
PO Box 6,
Bessemer Road,
Welwyn Garden City,
Herts AL7 1HD
07073-23400 Ex7414

Department of Trade and Industry,
MAP Information Centre,
Dean Bradley House,
52 Horseferry Road,
London SW1P 2AG
01-212 3411/5

Electrical Association for Women,
25 Foubert's Place,
London W1V 2AL
01-437 5212

Electricity Council,
Understanding Electricity,
30 Millbank,
London SW1P 4RD
01-834 2333 Ex6260

Electricity Supply Board, Ireland,
Understanding Electricity,
Lower Fitzwilliam Street,
Dublin 2

Girling Ltd.,
Publications Department,
Birmingham Road,
West Bromwich B71 4JR
021-553 2969

HMSO,
258 Broad Street,
Birmingham B1 2HE
021-643 3757

IBM,
Education Relations,
IBM South Bank,
76 Upper Ground,
London SE7 9PZ
01-928 1777

ICI,
Argus Film and Video Library,
15 Beaconsfield Road,
London NW10 2LE
01-451 1127

Kodak Ltd.,
Random Film Library Ltd.,
25 The Burroughs,
Hendon,
London NW4 4AT
01-936 2000

The National Centre for
Alternative Technology,
Machynlleth,
Powys,
Wales
Machynlleth (0654) 2400

Road Transport Industry
Training Board,
Information Centre,
Capitol House,
Empire Way,
Wembley,
Middlesex HA9 0NG
01-902 8880

Shell UK Ltd.,
Shell Education Service,
Shell-Mex House,
Strand,
London WC2R 0DX
01-257 1774

South of Scotland
Electricity Board,
Public Relations Department,
Cathcart House,
Glasgow G44 4BE
041-637 7177

Understanding British Industry,
Sun Alliance House,
New Inn Hall Street,
Oxford OX1 2QE
Oxford (0865) 722585

UKAEA (and NNC),
Information Services Branch,
11 Charles II Street,
London SW1Y 4QP
01-930 5454 Ex377

Kodak Ltd.,
Customer Relations,
PO Box 66,
Station Road,
Hemel Hempstead,
Herts HP1 1JU
Hemel Hempstead (0442) 61122

National Nuclear Corporation Ltd.,
Information Services Department,
Booths Hall,
Chelford Road,
Knutsford,
Cheshire WA16 8QZ
Knutsford (0565) 3800

Shell UK Ltd.,
Shell Film Library,
25 The Burroughs,
Hendon,
London NW4 4AT
01-936 2000

The Society of Dyers and Colourists,
PO Box 244,
Perkin House,
82 Grattan Road,
Bradford BD1 2JB
Bradford (0274) 725138

STC,
CFL Vision,
Distribution Centre,
Charlfont Grove,
Gerrards Cross,
Bucks SL9 8TN
Gerrards Cross (02407) 4433

Unilever PLC,
Education Section,
PO Box 68,
Unilever House,
Blackfriars,
London EC4P 4BQ
01-822 6727

UKAEA,
Slide Centre Ltd,
143 Chatham Road,
London SW11 6SR
01-223 3457

APPENDIX B

Documents, programs and data concerned with the
analysis of the Directory Questionnaire.

B.1 The Directory Questionnaire.

B.2 Programs for entering and analysing the
Questionnaire data.

B.3 Tables of data:

1. responses by record

2. responses by column

3. analysis of columns

Appendix B.1A DIRECTORY OF PHYSICS RESOURCE MATERIALS

Thank you very much for completing this questionnaire. It will help us to transfer you replies to computer more easily if you would USE A RED OR GREEN PEN.

Please fill in your name and the name of your school in the spaces given here, so that we can keep a record of replies. This information will be regarded as confidential; it will not be published and will not be made available outside the Department.

Your name:.....

Name of your school:

BACKGROUND

Question	Response	Code	Coding
Q1 In which type of educational establishment do you teach?	Comprehensive school	1	Q1 C1
	Sixth form college	2	
	Technical College	3	
*	Independent school	4	
.....	Other (*please specify)		
Q2 What is the average age of the youngest pupils in your school?	5-10	1	Q2 C3
	11-12	2	
	13-15	3	
	16+	4	
Q3 What is the average age of the oldest pupils in your school?	11-12	1	Q3 C5
	13-15	2	
	16-17	3	
	18+	4	
Q4 Approximately how big is your school's roll?	up to 200	1	Q4 C7
	200-500	2	
	500-700	3	
	700-1000	4	
	1000+	5	
Q5 In which category does your school fall?	Coeducational	1	Q5 C9
	Single sex M	2	
	Single sex F	3	
*	M with minority F	4	
.....	Other (*please specify)		
Q6 For how many years have you been teaching PHYSICS?	1-2	1	Q6 C11
	3-5	2	
	6-10	3	
	11-20	4	
	21+	5	

Q7	To how many groups do you teach Physics as a named subject below the sixth form?	Please enter the number of groups in the boxes (three=03 etc., none=00)	Q7		C13,14
Q8	To how many groups do you teach Physics as a component of a science course below the sixth form?	Please enter the number of groups in the boxes (three=03 etc., none=00)	Q8		C16,17
Q9	Do you enter candidates for an examination at 16+ which includes Physics?	No Yes	0 1	Q9	C19
Q10	Do you teach Physics at 'A'-level?	No Yes	0 1	Q10	C21
Q11	Which of these subjects do you teach (if any)? <Please enter a maximum of three subjects, in order of decreasing number of periods per week you teach.>	None Chemistry Biology Physical science General science Combined science Mathematics Electronics Computing CDT	0 1 2 3 4 5 6 7 8 9	Q11	C23 C24 C25
Q12	How long (in minutes) is an average single lesson in your school?	up to 30 31-40 41-45 46-50 51-60 60+	1 2 3 4 5 6	Q12	C27
Q13	How do you get information about materials produced by industry and other institutions? <Please put the most important source in C29 and the next most important in C30/C31.>	By post to your school From your Head of Dept. At school's resources centre At local teachers' centre From Science Advisor By writing to companies By reading journals etc. At ASE annual meeting	1 2 3 4 5 6 7 8	Q13	C29 C30 C31
Q14	Which of these educational publications do you read fairly regularly (if any)? <Please list them in order of decreasing frequency.> * *	None ASE: Educ. in Science School Sci. Rev. IoP: Physics Bulletin Physics Education 'Snippets' TES Education Guardian Other (* please specify)	0 1 2 3 4 5 6 7	Q14	C33 C34 C35 C36,37 C38,39

THE DIRECTORY

Q15 How many of the items in the Directory did you have already or hire regularly?	None	0	Q15	C41
	1-3	1		
	4-6	2		
	7-10	3		
	11-20	4		
	21+	5		
Q16 How many of the items in the Directory were you aware of, but had decided not to order?	None	0	Q16	C43
	1-3	1		
	4-6	2		
	7-10	3		
	11-20	4		
	21+	5		
Q17 How many items did you order as a result of receiving the Directory?	None	0	Q17	C45
	4-6	1		
	7-10	2		
	11-20	3		
	21+	4		
Q18 How many of the items you ordered as a result of receiving the Directory were free, save for postage and packing?	None	0	Q18	C47
	1-3	1		
	4-6	2		
	7-10	3		
	11-20	4		
	21+	5		
Q19 How would you prefer materials in the Directory to be arranged?	By syllabus i.e. the present arrangement	1	Q19	C49
	By format e.g. all film-loops together	2		
	By publisher/address from which materials could be obtained	3		

Please turn over:

YOUR USE OF MATERIALS

Q20 Which of these visual aids do you have available for your teaching on more than an occasional basis?

<Please list up to six you use most often, in order of decreasing frequency.>

Slide projector	01
Film loop projector	
standard 8	02
super 8	03
16mm film projector	04
OHP	05
film strip projector	06
video recorder	
U-matic	07
VHS	08
beta-max	09
Phillips	10
Microcomputer	
BBC/A	11
BBC/B	12
BBC/B + discdrive	13
RML	14
Spectrum	15
TV	16
Radio	17
Audio cassette player	18

Q20		C51/2
		C53/4
		C55/6
		C57/8
		C59/60
		C61/2

Q21 Which formats of material have you used in your teaching?

<Please list up to six you have used most, in order of decreasing frequency.>

Leaflet/booklet	01
Posters/wall-charts	02
Over-head transparencies	03
Enrichment packs	04
Films (16mm)	05
Film-loops	06
Film-strips	07
Video cassettes	08
TV programmes	09
Computer programs/simulations	10
Audio cassettes	11
35mm Slides	12
Slide/tape sequences	13

Q21		C63/4
		C65/6
		C67/8
		C69/70
		C71/2
		C73/4

Q22 If you use films or video cassettes, how do you obtain them?

Borrow from a free library	1
Hire from a library	2
Buy them	3
Tape them off air from TV	4

Q22		C76
-----	--	-----

Q23 Excluding films and video cassettes, what is the MAXIMUM part of a lesson for which you have used 'industrial' materials?

Up to 5 minutes	1
Up to a quarter of an hour	2
Half a lesson	3
A whole lesson	4
A double lesson	5

Q23		C78
-----	--	-----

Thank you for completing the questionnaire. We will hope to send you a summary of our findings in due course.

Please return to:

The Compiler,
Physics Resources Directory,
8 Springhill,
Rugby,
Warwicks CV22 5PY

Please leave blank

	C80
--	-----

by 15th July, if possible.

Appendix B.2

Program 1 - RECDATA

```

10 REM:*****
20 REM: RECDATA PROGRAM *
30 REM: PFB 27/12/85 *
40 REM: TO RECORD QUESTIONNAIRE *
50 REM:*****
60 REM:
70 REM: Main program 160-320
80 REM: PROCcenter 360-450
90 REM: PROCfillLQ 480-560
100 REM: PROCTab(N%) 590-640
110 REM: PROCconcat 680-730
120 REM: PROCcheck 770-840
130 REM: PROCdislay(N%) 870-920
140 REM: PROCcorrect 960-1060
150 REM: PROCrecord 1100-1150
160ONERRORGOTO 310
170nr%=OPENUP"physdir"
180DIM Q$(24):DIM LQ%(24):L%=81
190PROCfillLQ
200 MODE 7
210PROCcenter
220PROCconcat
230 MODE 0:PROCcheck
240 INPUT TAB(40,25) "Correction (C) Repeat entry (R)"A$
250 IF A$="C" THEN 280
260 IF A$="R" THEN 210
270 IF A$<>"C" AND A$<>"R" THEN 290
280PROCcorrect
290PROCrecord
300 GOTO 200
310ONERROROFF:CLOSE#0:REPORT:PRINT" in line ";ERL
320 END
330 REM
340 REM
350 REM
360DEFPROCcenter
370ex%=EXT#nr%:rn%=(ex%DIVL%)+1:ch%=ex%MODL%:CLS
380IF ch%<>0 PRINT"EXT 'PHYSDIR' is not a multiple of ";L%
390PRINT"Enter record #";rn%:PRINT
400FOR N%=1 TO 24
410 PROCTab(N%)
420PRINT TAB(x%,y%) "Q";N%:INPUT TAB(x%+3,y%) " Q$(N%)
430 IF LEN(Q$(N%))<>LQ%(N%) THEN 420
440NEXT N%
450ENDPROC
460 REM
470 REM
480DEFPROCfillLQ
490FOR N%=1 TO 24
500READ LQ%(N%)
510NEXT N%
520DATA 1,1,1,1,1,1
530DATA 2,2,1,1,3,1
540DATA 3,7,1,1,1,1
550DATA 1,12,12,2,1,1
560ENDPROC
570 REM
580 REM
590DEFPROCTab(N%)
600IF N%<25 x%=24:y%=N%-18
610IF N%<20 x%=16:y%=N%-13
620IF N%<15 x%=8:y%=N%-5
630IF N%<7 x%=0:y%=N%+1
640ENDPROC
650 REM
660 REM
670 REM
680DEFPROCconcat
690 R$=""
700FOR N%=1 TO 24
710IF N%=20 OR N%=22 THEN R$=R$+Q$(N%) ELSE R$=R$+Q$(N%)+ " "
720NEXT N%
730ENDPROC
740 REM
750 REM

```

```

760 REM
770 DEF PROC check
780 ln% = LEN(R%); CLS
790 IF ln% < L% PRINT "Record is not the correct length, it has
      "ln% bytes."
800 FOR NZ = 1 TO L%
810 PROC display(NZ)
820 C% = MID$(R%, NZ, 1); PRINT TAB(x%, y%) C%; " C"; NZ
830 NEXT NZ
840 END PROC
850 REM
860 REM
870 DEF PROC display(NZ)
880 IF NZ < 82 x% = 60; y% = NZ - 61
885 IF NZ < 63 x% = 45; y% = NZ - 49
890 IF NZ < 51 x% = 30; y% = NZ - 39
900 IF NZ < 41 x% = 15; y% = NZ - 11
910 IF NZ < 13 x% = 0; y% = NZ + 1
920 END PROC
930 REM
940 REM
950 REM
960 DEF PROC correct
970 LOCAL C%
980 INPUT "Enter the column for correction"; NZ
990 IF NZ = 0 THEN 1060
1000 C% = MID$(R%, NZ, 1); PRINT C%; "C"; NZ
1010 INPUT "Enter the correct value"; C%
1020 R% = LEFT$(R%, NZ - 1) + C% + RIGHT$(R%, L% - NZ)
1030 PROC check
1040 INPUT "Further corrections (Y/N)"; Y%
1050 IF Y% = "Y" OR Y% = "y" THEN 980
1060 END PROC
1070 REM
1080 REM
1090 REM
1100 DEF PROC record
1110 FOR NZ = 1 TO L%
1120 PTR#nr% = ex% + NZ - 1
1130 BPUT#nr%, ASC(MID$(R%, NZ, 1))
1140 NEXT NZ
1150 END PROC

```

Program 2 - FILECOL

```

02 REM: *****
03 REM: *
04 REM: * PROGRAM TO CONVERT PHYSIDR *
05 REM: * *
06 REM: * TO COLUMN FORMAT *
07 REM: * *
10 REM: * PFB 29.12.85 *
11 REM: * *
12 REM: *****
20 REM:
30 REM:
400 ERROR GOTO 110
50 nr% = OPENUP "physdir"
60 ex% = EXT#nr%; rn% = ex% DIV 81
70 IF ex% < 0 PRINT "EXT 'PHYSIDR' is not a multiple of 81!"
80 PROC filecolumns
90 CLOSE#nr%
100 END
1100 ERROR OFF; CLOSE#0; REPORT; PRINT " in line "; ERL
120 REM
130 REM
140 REM
150 DEF PROC filecolumns
160 n% = OPENOUT "C"
170 FOR P% = 1 TO 81
180 C% = " "
190 FOR R% = 1 TO rn%
200 PTR#nr% = (R% - 1) * 81 + (P% - 1); B% = BGET#nr%
210 C% = C% + CHR$(B%)
220 NEXT R%
230 PRINT#n%, C%; PRINT C%
240 NEXT P%
250 CLOSE#n%

```

260ENDPROC

Program 3 - COL/STR

```

10REM:*****
20REM:*
30REM:* PROGRAM TO TAKE DATA *
40REM:*
50REM:* FROM 'C' AND ADJUST *
60REM:*
70REM:* FOR DOUBLE-LENGTH *
80REM:*
90REM:* AND NULL STRINGS *
100REM:*
110REM:* PFB 29.12.85 *
120REM:*****
130ONERROR GOTO 220
140DIM C$(81)
150nr%=OPENUP"physdir"
160ex%=EXT#nr%:irn%=%XDIV81
170CLOSE#nr%
180PROCfillstrings
190PROCprintstrings
200PROCrecordstrings
210END
220ONERROR OFF:CLOSE#0:REPORT:PRINT" in line ";ERL
230REM
240REM
250REM
260DEFPROCfillstrings
270nr%=OPENUP"C"
280 FOR C%=1 TO 81
290 INPUT#nr%,C$(C%)
300 NEXT C%
310CLOSE#nr%
320ENDPROC
330ENDPROC
340REM
350REM
360REM
370DEFPROCprintstrings
380VDU14
390 FOR P%=1 TO 81
400PRINT "C";P%:" ";C$(P%)
410 NEXT P%
420VDU15
430ENDPROC
440REM
450REM
460REM
470DEFPROCrecordstrings
480LOCAL C%
490st%="OPENOUT("columns")
500READ C%,nb%,max%
510 FOR P%=1 TO 81
520C%=""
530IF P%=C% AND nb%=2 THEN FOR R%=1 TO
rn%:C%=C%+FNMAT(C%,R%)+FNMAT(C%+1,R%):NEXT R%:C$(C%)=C%:C$(C%+1)=""
540IF P%=C% PRINT#st%,C$(C%)
550IF P%=C% THEN READ C%,nb%,max%
560 NEXT P%
570CLOSE#st%:RESTORE
580REM
590REM
600 DATA 1,1,6,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
610 DATA 13,2,10,16,2,10,19,1,1,21,1,1,23,1,9
620 DATA 24,1,9,25,1,9,27,1,6,29,1,8,30,1,8,31,1,8
630 DATA 33,1,9,34,1,9,35,1,9,36,2,10,38,2,10,39,1,8
640 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,3,51,2,18
650 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18,63,2,18
660 DATA 65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
670 DATA 76,1,4,77,1,4,78,1,5,80,1,3,0,0,0
680REM
690REM
700REM
710DEF FNMAT(C%,R%)=MID$(C$(C%),R%,1)

```

Program 4 - READphy

```

10REM:*****
20REM:*
30REM:* PROGRAM TO SHOW RECORDS *
40REM:*
50REM:* CONTENTS WITHIN physdir *
60REM:*
70REM:* PFB 29.12.85 *
80REM:*****
90REM:
100ONERROR GOTO 240
110REM:
120MODE 3
130nr%=OPENUP"physdir"
140ex%=EXT#nr%:rn%ex%DIV81:ch%ex%MOD81:CLS
150IF ch%>0 PRINT"EXT 'PHYSDIR' is not a multiple of 81":PRINT
160PRINT"PHYSDIR contains ";rn%;" records.":PRINT
170FOR CX=1 TO ex%
180PTR#nr%=CX-1:R%=(CX-1)DIV81:md%=(CX-1)MOD81
190IF md%=0 PRINT:PRINT"Record #";R%+1;" "
200VDU BGET#nr%
210NEXT CX
220CLOSE#nr%
230END
240ONERROR OFF:CLOSE#0:REPORT:PRINT" in line ";ERL

```

Program 5 - READcol

```

10REM:*****
20REM:*
30REM:* PROGRAM TO READ THE *
40REM:*
50REM:* COLUMN STRINGS FROM *
60REM:*
70REM:* columns *
80REM:* PFB 29.12.85 *
90REM:*****
100DIMC$(81)
110st%=OPENUP"columns"
120REPEAT
130READ CX,nb%,max%
140INPUT#st%,C$(CX)
150 IF CX<10 PRINT;"C";"0";CX;" " "C$(CX):GOTO 170
160 PRINT;"C";CX;" " "C$(CX)
170UNTIL EOF#st%
180CLOSE#st%
190 DATA 1,1,6,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
200 DATA 13,2,10,18,2,10,19,1,1,21,1,1,23,1,9
210 DATA 24,1,9,25,1,9,27,1,6,29,1,8,30,1,8,31,1,8
220 DATA 33,1,9,34,1,9,35,1,9,36,2,10,38,2,10
230 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,3,51,2,18
240 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18
250 DATA 63,2,13,65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
260 DATA 76,1,4,77,1,4,78,1,5,80,1,3,0,0,0

```

Program 6 - STATTOT

```

10REM:*****
20REM:*
30REM:* STATISTICAL PROGRAM TO *
40REM:*
50REM:* PERFORM A TOTAL COUNT *
60REM:*
70REM:* ON THE COLUMN STRINGS *
80REM:*
90REM:* PFB 15.4.86 *
100REM:*****
110ONERROR GOTO 240
120DIMC$(81)
130st%=OPENUP"columns"
140REPEAT
150READ CX,nb%,max%
160INPUT#st%,C$(CX)
170UNTIL EOF#st%
180CLOSE#st%
190MODE 3
200REM: To find distributions for C1-80

```



```

210PROCstats
220MODE 7
230END
240ONERROROFF:CLOSE#st%:REPORT:PRINT" in line ";ERL:END
250 DATA 1,1,9,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
260 DATA 13,2,16,16,2,22,19,1,1,21,1,1,23,1,9
270 DATA 24,1,9,25,1,9,27,1,6,29,1,8,30,1,8,31,1,8
280 DATA 33,1,9,34,1,9,35,1,9,36,2,10,38,2,10
290 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,5,51,2,18
300 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18
310 DATA 63,2,13,65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
320 DATA 76,1,4,77,1,4,78,1,5,80,1,3,0,0,0
330DEFFPROCstats
340VDU2:VDU1,27,1,33,1,4:VDU1,27,1,85,1,1
350RESTORE
360REPEAT
370READ CX,nb%,max%:sum%=0:X=6:total%=0
380PRINT"C",CX:
390 FOR V=0 TO max%
400 FOR RX=1 TO LEN(C$(1))
410R%=nb%*(RX-1)+1
420N%=FNMAT(CX,r%,nb%)
430IF VAL(N%)=V THEN sum%=sum%+1:total%=total%+1
440 NEXT RX
450PRINT TAB(X);V;"-";sum%
460sum%=0:X=X+6
470 NEXT V
480PRINT TAB(125);total%
490UNTIL CX=0
500VDU3
510ENDPROC
520DEFFNMAT(CX,r%,nb%)=MID$(C$(CX),r%,nb%)

```

Program 7 - STATBEL

```

10REM:*****
20REM:
30REM: PROGRAM TO TAKE
40REM:
50REM: SELECTED STATISTICS
60REM:
70REM: AND COMPARE COLUMNS
80REM: PFB 15.4.86
90REM:*****
100ONERROR GOTO 500
110REM: To read the column strings
120DIM C$(81):DIM P$(81,3)
130st%=OPENUP"columns":RESTORE
140REPEAT
150READ CX,nb%,max%
160INPUT#st%,C$(CX)
170UNTIL EOF#st%
180CLOSE#st%
190REM:
200REM: To fill the parameters array
210RESTORE
220REPEAT
230READ CX,nb%,max%
240P$(CX,1)=CX
250P$(CX,2)=nb%
260P$(CX,3)=max%
270UNTIL CX=80
280REM:
290REM:
300REM: To enter the columns to
310REM: be compared.
320REPEAT
330CLS:INPUT"Give the number of the 1st column",C1:PRINT
340 IF C1<1 OR C1>80 THEN GOTO 330
350INPUT"Give the number of the 2nd column",C2:PRINT
360 IF C2<1 OR C2>80 THEN GOTO 350
370MODE 3
380PROCstats
390MODE 7
400UNTIL FALSE
410END
420 DATA 1,1,9,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
430 DATA 13,2,16,16,2,22,19,1,1,21,1,1,23,1,9

```

```

440 DATA 24,1,9,25,1,9,27,1,6,29,1,8,30,1,8,31,1,8
450 DATA 33,1,9,34,1,9,35,1,9,36,2,10,38,2,10
460 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,3,51,2,18
470 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18
480 DATA 63,2,13,65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
490 DATA 75,1,4,77,1,4,78,1,5,80,1,3,0,0
500 ONERROR OFF; CLOSE #0; VDU3:REPORT; PRINT " in line "; ERL
510 REM:
520 REM:
530 REM: To perform the statistics
540 REM: on the two selected columns
550 REM:
560 REM:
570 DEFFPROC stats
580 grandtot%=0
590 VDU1,27,1,33,1,4; VDU1,27,1,85,1,1; VDU2
600 FOR V1%=0 TO P%(C1%,3)
610 PRINT "For C"; C1%; " = "; V1%
620 PRINT "C"; C2%; " = ";
630 total%=0; X=7
640 FOR V2%=0 TO P%(C2%,3)
650 sum%=0
660 FOR R%=1 TO LEN(C$(1))
670 r1%=P%(C1%,2)*(R%-1)+1; r2%=P%(C2%,2)*(R%-1)+1
680 n1%=FNMAT(C1%,r1%,P%(C1%,2)); n2%=FNMAT(C2%,r2%,P%(C2%,2))
690 IF VAL(n1%)=V1% AND VAL(n2%)=V2% THEN
sum%=sum%+1; total%=total%+1
700 NEXT R%
710 PRINT TAB(X); V2%; "-"; sum%; X=X+7
720 NEXT V2%
730 PRINT TAB(127); total%; grandtot%=grandtot%+total%
740 NEXT V1%
750 PRINT "Total number of records = "; grandtot%
760 PRINT; PRINT
770 VDU3
780 ENDPROC
790 DEFFNMAT(C%,r%,nb%)=MID$(C$(C%),r%,nb%)

```

Program 9 - SPLSTAT

```

10 REM: *****
20 REM: *
30 REM: * PROGRAM TO SPOOL THE *
40 REM: * *
50 REM: * RESULTS OF STATSEL *
60 REM: * PFB 15.4.86 *
70 REM: *****
80 ON ERROR GOTO 490
90 REM: To read the column strings
100 DIM C$(81); DIM P$(81,3)
110 st%=OPENUP"columns"; RESTORE
120 REPEAT
130 READ CX,nb%,max%
140 INPUT st%,C$(CX)
150 UNTIL EOF=st%
160 CLOSE st%
170 REM:
180 REM: To fill the parameters array
190 RESTORE
200 REPEAT
210 READ CX,nb%,max%
220 P%(CX,1)=CX
230 P%(CX,2)=nb%
240 P%(CX,3)=max%
250 UNTIL CX=80
260 REM:
270 REM:
280 REM: To enter the columns to
290 REM: be compared.
300 MODE 3
310 INPUT "If you wish to use another disc, insert it now." Z%; IF
Z=<>"C" GOTO 310
320 SPOOL cmpstat
330 REPEAT
340 INPUT "C"; C1%; "/" C2%
350 IF C1%<1 OR C1%>80 THEN GOTO 340
360 IF C2%<1 OR C2%>80 THEN GOTO 340

```

```

370PROCstats
380UNTIL FALSE
390*SPool
400END
410 DATA 1,1,9,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
420 DATA 13,2,16,16,2,22,19,1,1,21,1,1,23,1,9
430 DATA 24,1,9,25,1,4,27,1,6,29,1,8,30,1,8,31,1,8
440 DATA 33,1,9,34,1,9,35,1,9,36,2,10,38,2,10
450 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,3,51,2,18
460 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18
470 DATA 63,2,13,65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
480 DATA 76,1,4,77,1,4,78,1,5,80,1,3,0,0,0
490 ONERROR OFF;CLOSE#0;VDU3;REPORT;PRINT" in line ";ERL
500 REM:
510 REM:
520 REM: To perform the statistics
530 REM: on the two selected columns
540 REM:
550 REM:
560DEFPROCstats
570grandtot%=0
580 FOR V1%=0 TO P%(C1%,3)
590PRINT"For C";C1%;"=";V1%
600PRINT"C";C2%;"=";V2%
610total%=0;X=7
620 FOR V2%=0 TO P%(C2%,3)
630sum%=0
640 FOR R%=1 TO LEN(C$(1))
650r1%=P%(C1%,2)*(R%-1)+1;r2%=P%(C2%,2)*(R%-1)+1
660n1%=FNMAT(C1%,r1%,P%(C1%,2));n2%=FNMAT(C2%,r2%,P%(C2%,2))
670IF VAL(n1%)=V1% AND VAL(n2%)=V2% THEN
sum%=sum%+1;total%=total%+1
680 NEXT R%
690PRINT TAB(X);V2%;"-";sum%;;X=X+7
700 NEXT V2%
710PRINT TAB(127);total%;grandtot%=grandtot%+total%
720 NEXT V1%
730PRINT"Total number of records = ";grandtot%
740PRINT;PRINT
750ENDPROC
760DEFFNMAT(C%,r%,nb%)=MID$(C$(C%),r%,nb%)

```

Program 9 - STATSET

```

10REM:*****
20REM: *
30REM: * PROGRAM TO CALCULATE *
40REM: * *
50REM: * SELECTED STATISTICS *
60REM: * *
70REM: * FOR COLUMN GROUPS *
80REM: * PFB 15.7.86 *
90REM:*****
100ONERROR GOTO 490
110REM: To read the column strings
120DIM C$(81);DIM P%(81,3)
130*TX=OPENUP"columns";RESTORE
140REPEAT
150READ C%,nb%,max%
160INPUT*TX,C$(C%)
170UNTIL EOF*TX
180CLOSE*TX
190REM:
200REM: To fill the parameters array
210RESTORE
220REPEAT
230READ C%,nb%,max%
240P%(C%,1)=C%
250P%(C%,2)=nb%
260P%(C%,3)=max%
270UNTIL CX=80
280REM:
290REM:
300REM: To enter the columns to
310REM: be compared.
320MODE 3
330INPUT"If you wish to use another disc, insert it now."Z;IF

```

```

2* < "C" GOTO 330
340 * SPPOOL setstat
350 REPEAT
360 PROCinput
370 PROCstats
380 UNTIL FALSE
390 * SPPOOL
400 END
410 DATA 1,1,9,3,1,4,5,1,4,7,1,5,9,1,6,11,1,5
420 DATA 13,2,16,16,2,22,19,1,1,21,1,1,23,1,9
430 DATA 24,1,9,25,1,9,12,1,6,29,1,8,30,1,8,31,1,8
440 DATA 33,1,10,34,1,10,35,1,10,36,2,10,38,2,10
450 DATA 41,1,5,43,1,5,45,1,4,47,1,5,49,1,3,51,2,18
460 DATA 53,2,18,55,2,18,57,2,18,59,2,18,61,2,18
470 DATA 63,2,13,65,2,13,67,2,13,69,2,13,71,2,13,73,2,13
480 DATA 76,1,4,77,1,4,78,1,5,80,1,3,0,0,0
490 ONERROR OFF; CLOSE #0; VDUS; REPORT; PRINT " in line "; ERL
500 REM:
510 REM:
520 REM: To perform the statistics
530 REM: on the two selected columns
540 REM:
550 REM:
560 DEF PROCstats
570 grandtot% = 0
580 FOR V1% = 0 TO P%(C1%, 3)
590 PRINT "For C"; C1%; "="; V1%
600 PRINT "C"; C2%; "-" C"; C3%;
610 total% = 0; X = 1
620 FOR V2% = 0 TO P%(C2%, 3)
630 sum% = 0
640 col% = C2%
650 REPEAT
660 FOR R% = 1 TO LEN(C$(1))
670 r1% = P%(C1%, 2) * (R% - 1) + 1; r2% = P%(col%, 2) * (R% - 1) + 1
680
n1% = MID$(C$(C1%), r1%, P%(C1%, 2)); n2% = MID$(C$(col%), r2%, P%(col%, 2))
690 IF VAL(n1%) = V1% AND VAL(n2%) = V2% THEN
sum% = sum% + 1; total% = total% + 1
700 NEXT R%
710 col% = col% + P%(col%, 2)
720 UNTIL col% > C3%
730 PRINT TAB(X); V2%; "-"; sum%; X = X + 7
740 NEXT V2%
750 PRINT TAB(127); total%; grandtot% = grandtot% + total%
760 NEXT V1%
770 PRINT "Total number of records = "; grandtot%
780 PRINT; PRINT
790 ENDPROC
800 DEF PROCinput
810 CLS
820 INPUT
C" C2% TAB(12, 0) "-" C" TAB(14, 0) C3% and
830 IF C1% < 1 OR C1% > 80 THEN GOTO 820
840 IF C2% < 1 OR C2% > 80 THEN GOTO 820
850 IF C3% < 1 OR C3% > 80 THEN GOTO 820
860 ENDPROC

```

Appendix B.3

Table 1

Summary of the responses to the questionnaire by record.

'PHYSIDIR' contains 99 records.

Record #01	1 2 4 4 1 4 02 03 0 1 45	2 127 67203	4 3 2 3 1	080301050212080612070603	4 2 2
Record #02	1 2 3 5 1 1 00 05 1 0 53	5 761 12706	2 2 2 2 3	0508011816040902010813	4 3 2
Record #03	5 2 4 3 3 3 04 00 1 1 7	2 17 12506	0 4 0 0 2	1205080116 10080203	141 2
Record #04	1 2 4 5 1 4 04 02 1 1 54	2 712 14205	4 5 1 1 3	0504010912 030102050810	144 3
Record #05	4 3 3 2 4 4 04 00 1 1 6	2 127 21506	0 0 0 0 1	050104 0	1 0 3
Record #06	1 4 4 2 1 5 00 01 0 1 7	6 781 2410508	2 1 1 1 1	0502120104 01031308	1 2 3
Record #07	1 2 4 5 1 5 02 02 1 1 3	5 178 6740502	3 2 1 1 2	010406081305051202060710	133 3
Record #08	4 3 4 4 2 4 03 00 1 1 354	2 71 6410205	2 0 0 0 1	0501081413041009120602	4 1 3
Record #09	5 2 4 4 1 4 02 00 1 1 0	2 617 2150406	3 3 2 3 1	080113160305081201021006	4 2 3
Record #10	1 2 2 5 1 3 07 01 1 0 5	2 168 2140506	1 0 1 2 2	091205011804100804031210	4 4 3
Record #11	6 2 4 5 2 1 03 02 1 1 24	2 712 16702	2 1 1 2 2	050408010213020508071003	144 3
Record #12	1 2 3 3 1 4 07 02 1 0 5	2 176 71205	4 1 1 1 1	14150506160810020107	4 0 3
Record #13	1 2 4 5 1 3 07 01 1 1 59	2 173 125	1 0 0 0 1	0105060818 121301020807	4 4 3
Record #14	1 2 3 4 1 4 04 06 1 0 546	2 361 215	5 4 3 1	050801040618010203090805	1 2 3
Record #15	1 2 3 4 1 4 02 18 1 0 48	2 175 6520107	3 4 0 0 1	020506010813060302071008	4 2 2
Record #16	1 2 3 5 1 2 04 02 1 1 3	2 2 0	0 0 0 0 1	09 0801	4 5 2
Record #17	1 2 3 4 1 3 04 00 0 0 51	2 157 612	1 5 2 3 1	080105021216081301020910	1 3 2
Record #18	1 2 4 5 1 4 10 06 1 1 347	5 147 12506	5 3 1 2 1	070112181716011302040810	1 5 3
Record #19	1 3 3 5 1 4 02 00 1 1 7	6 17 575	3 3 3 4 1	050816011318030102081310	4 1 2
Record #20	1 2 4 5 1 3 03 00 1 1 0	2 716 6720500	0 0 0 0 0	051308160114081012	4 2 2
Record #21	1 2 4 4 3 4 03 03 0 1 46	2 715 6120305	0 3 0 0 1	08161317180508020103	1 1 2
Record #22	1 2 2 3 1 3 00 06 0 0 568	6 168 2650100	4 4 1 1 2	040601081218080102100507	2 5 2
Record #23	1 2 4 4 1 5 05 00 1 1 0	2 51 12305	0 0 0 0 1	05081216 03080910	1 2 2
Record #24	1 2 2 4 1 3 00 06 0 0 5	5 178 12605	5 5 2 3 1	04010811 0502011209	1 4 2
Record #25	1 2 4 5 1 4 04 01 1 1 74	3 175 6210500	5 5 3 2 1	1308050401 0110020805	4 5 2
Record #26	1 2 3 5 1 4 05 04 1 1 4	2 127 67105	1 2 0 1 1	010914061617010210030412	4 4 2
Record #27	4 2 3 3 1 2 05 00 0 1 7	2 76 67	0 0 0 0 3	051201 010210	0 4 2
Record #28	1 2 2 5 1 4 03 03 1 0 457	2 167 12405	3 2 0 0 1	050801161302020812030105	142 2
Record #29	1 3 3 4 1 3 05 02 1 1 379	4 671 6540302	3 4 2 3 2	010508131618010207050813	4 4 2
Record #30	1 3 3 4 1 5 03 00 1 1 387	4 147 152	0 3 2 2 1	120905030116100912020508	4 3 2
Record #31	4 2 2 4 1 5 16 04 0 0 1	5 178 125	1 4 0 0 0	051201060408031002050612	1 2 2
Record #32	4 3 4 3 4 2 03 00 1 1 0	2 718 2760305	1 2 1 1 1	080105 010302080612	3 2 3
Record #33	1 2 4 5 1 5 05 05 1 1 0	6 146 1250607	5 0 1 2 1	0	1 4 3
Record #34	1 2 4 5 1 3 08 05 1 1 45	5 761 4510206	1 0 1 1 1	080501041216010203080910	4 1 3
Record #35	1 2 4 5 1 4 06 02 0 1 5	6 718 61205	5 3 0 0 1	080513010418020108121305	1 4 3
Record #36	2 4 4 3 1 2 00 00 1 1 0	6 127 7120605	3 2 2 3 2	0805010212180201030810	4 2 3
Record #37	1 2 3 4 1 5 06 01 1 0 51	2 167 125	3 2 0 0 2	08050106 081203010213	3 2 3
Record #38	1 2 3 5 1 2 07 08 1 1 5	2 267 21607	1 3 2 3 2	08 020805	412 3
Record #39	1 2 3 4 1 4 05 22 1 1 512	2 376 16910	4 4 0 0 1	050801121617100809030102	0 4 2
Record #40	1 3 4 5 1 1 04 00 1 1 8	5 67 61207	1 0 3 3 1	1308051416 030801020910	0 3 3
Record #41	1 2 2 3 1 4 00 06 0 0 516	4 157 1620405	3 4 3 4 1	080105060403020812030105	4 3 2
Record #42	1 2 4 4 1 4 07 00 1 1 0	2 1 567	0 1 4 4 2	081605 01020908	4 3 3
Record #43	1 3 3 3 1 2 04 01 1 1 42	2 871 21	4 1 0 0 2	08040115 080902	1 4 3
Record #44	1 2 3 5 1 3 01 02 1 0 135	2 175 216	1 3 1 0 2	080105041316081309011102	4 5 3
Record #45	1 2 4 5 1 5 02 02 1 1 345	6 165 85	1 0 0 0 1	050801061204030812070102	1 4 2
Record #46	1 2 3 5 1 4 03 01 0 1 5	6 178 2610504	5 0 0 0 1	081305150604080102091012	1 3 2
Record #47	1 2 4 5 1 5 06 02 0 1 4	2 175 15206	3 4 1 1 1	1004120105 050201100812	4 4 3
Record #48	1 2 3 3 1 2 03 02 1 0 49	2 178 21605	4 5 1 2 1	0805041813 0803050110	4 5 2
Record #49	4 2 4 2 4 5 03 00 0 1 0	3 781 2140506	3 1 0 0 2	081305010403080310120511	4 3 3
Record #50	1 3 4 4 1 4 05 02 0 1 124	6 145 12506	5 5 1 2 1	01 091003010212	4 3 2
Record #51	1 2 0 0 1 5 06 01 1 1 111	2 678 12507	0 0 0 0 1	080513060418080203091012	4 3 2
Record #52	1 2 3 5 1 1 04 04 1 1 54	2 67 12304	0 0 2 0 1	01040814 0802051213	142 3
Record #53	1 2 4 5 1 3 07 00 0 1 0	5 176 6240507	2 2 2 3 1	0813010516 02091012	4 3 2
Record #54	1 2 4 5 1 5 03 02 1 1 54	2 174 6340501	4 4 0 0 1	081601051304090810120102	4 3 2
Record #55	1 2 5 1 2 06 00 1 1 798	2 712 652	5 5 1 2 1	1608010405 0201130810	4 2 2
Record #56	4 3 4 3 2 4 04 00 1 1 0	2 276 624	0 0 0 0 1	050108130402030805121009	4 1 3
Record #57	7 1 2 2 1 2 00 03 0 0 598	3 167 0	1 1 1 0 1	030813171904100913030507	1 4 2
Record #58	1 2 4 5 1 3 04 02 1 1 459	2 187 1240506	3 2 0 0 1	0109040506030102050910	1 3 3
Record #59	4 2 4 4 4 4 02 00 1 1 7	2 178 3410205	5 4 2 2 1	130702040116100803010605	142 3
Record #60	1 3 4 4 2 4 04 00 1 1 7	2 167 1250607	5 5 0 0 2	041005011202050906021012	141 3
Record #61	1 2 2 5 1 4 03 02 0 0 95	2 165 12507	2 2 2 3 1	081501181405081001020412	4 4 3
Record #62	8 4 4 5 1 4 00 00 0 1 0	5 217 24105	3 3 1 1 1	0513070104 01121008	4 2 3
Record #63	1 2 4 2 1 3 05 01 1 1 5	2 715 1230406	1 1 0 0 1	080405120103080502100112	4 2 3
Record #64	1 2 3 4 1 4 01 02 1 0 15	5 167 691	1 3 0 0 1	081318010504131005020801	4 3 2
Record #65	4 2 4 4 2 4 03 01 1 1 97	2 817 21504	2 2 1 1 1	0805010218 1008111202	4 2 3
Record #66	1 3 3 3 1 4 06 02 1 1 59	2 127 2510304	1 1 0 0 1	05080406121503080902	4 1 2

Record #67	1 2 2 3 1 4 01 02 1 0 14	2 37 56	3 2 1 1 1	0816120415	08021009	1 2 2
Record #68	1 2 4 5 1 4 04 02 1 1 71	6 168 61205	3 3 1 1 2	0805040601	08020109	4 4 2
Record #69	1 2 3 3 1 3 07 01 1 0 521	3 712 6510204	5 4 3 4 1	0804010605	01020805	2 5 2
Record #70	1 2 2 4 1 3 07 04 0 0 5	2 172 21507	5 5 0 0 2	160805011404080102031210		4 4 3
Record #71	1 3 4 5 1 4 08 00 1 1 0	4 675 6210405	0 2 0 0 1	050801120418030813100612		4 4 3
Record #72	1 2 4 5 1 2 05 00 0 1 8	2 142 25710	1 0 0 0 1	081314	0810	4 0 3
Record #73	1 2 4 4 1 4 04 01 1 1 74	5 712 62504	1 4 1 2 1	081304051601081005031201		4 4 1
Record #74	2 4 4 3 1 4 00 00 0 1 0	5 1 34506	0 0 0 0 2	01030408	1206080203	4 4 1
Record #75	5 3 4 4 1 3 03 02 1 1 53	6 871 21	0 0 0 0 1	0501080412	120108051210	4 5 1
Record #76	1 2 2 4 1 3 06 04 0 0 521	5 176 21605	5 3 2 5 1	050708040612031208010205		4 4 2
Record #77	4 1 1 1 1 5 00 02 0 0 236	2 761 126	0 0 0 0 1	01061316171801020509		1 3 3
Record #78	1 3 3 5 1 4 02 02 1 1 4	2 157 1230405	1 3 0 0 1	0103050608	010306091012	4 3 1
Record #79	3 4 4 5 1 5 02 01 1 1 3	6 715 32105	3 0 3 3 1	050612080402031202070510		2 3 1
Record #80	1 3 4 5 1 4 04 01 1 1 34	4 12 673	1 0 4 5 1	0408130501	0508011002	1 3 1
Record #81	1 2 3 3 1 4 02 04 1 0 47	2 2 12	0 2 0 0 1	0813	0102030508	241 1
Record #82	1 2 3 4 1 4 02 06 1 0 4	2 1 25406	1 2 0 0 0	08051804	08111202	0 1 1
Record #83	1 2 3 4 2 4 04 01 1 0 451	2 71 123	5 4 4 4 1	050801060416091203021305		1 3 2
Record #84	1 2 4 5 1 3 06 00 1 1 41	2 175 1260305	3 2 0 0 1	0405081216	0502080901	4 2 1
Record #85	9 2 4 5 1 4 03 00 1 1 7	2 718 2410506	3 4 0 0 1	05081314	030810	4 1 3
Record #86	1 2 3 4 1 4 00 03 1 0 598	2 768 6710205	5 5 2 3 3	050806011813010204090710		4 5 2
Record #87	1 2 3 5 1 4 06 02 1 0 400	2 000 6540102	0 0 1 2 1	051416080104031002080000		1 5 2
Record #88	1 2 4 5 1 4 07 02 0 1 571	2 126 6500000	0 0 0 0 1	130805160104080910030100		4 2 3
Record #89	1 2 2 4 1 2 01 02 0 0 120	2 710 2160000	2 0 1 1 1	130805040000100901000000		1 2 2
Record #90	4 3 4 3 4 5 03 00 0 1 000	3 176 1250600	0 0 0 0 2	010204051308101205060802		3 3 3
Record #91	1 2 3 4 1 4 08 02 1 0 547	2 175 6210000	2 4 2 2 1	080405121500030508100200		1 3 2
Record #92	4 1 2 2 1 4 00 08 0 0 560	2 716 1260000	3 2 2 2 1	160801060513010208091203		1 3 3
Record #93	1 2 3 5 1 5 06 01 1 0 000	2 167 5200000	0 0 0 0 0	090416010212080509120201		1 4 3
Record #94	1 2 3 5 1 4 00 00 0 1 340	2 710 2650700	5 0 0 0 1	081605010304090103060500		4 3 3
Record #95	1 2 4 5 2 5 04 00 1 1 000	2 178 2150600	3 5 0 0 1	051308011604100809121305		1 3 3
Record #96	1 2 3 4 1 3 06 04 1 0 159	2 176 1250406	2 1 0 0 3	051608120118080203110710		1 3 3
Record #97	1 1 1 3 1 4 00 05 0 0 540	2 415 6000000	0 0 1 1 1	050816060000030809010207		4 4 2
Record #98	1 2 3 4 4 3 03 01 1 1 794	2 178 2150000	0 0 0 0 0	010405060813030908051001		4 1 3
Record #99	1 2 3 4 1 3 03 07 0 0 510	2 156 1260000	1 3 1 2 1	050818060206030113020811		1 3 3

Table 2

Responses collected by column.

[illegible]

10811051604051 604121 60201040 60303161 60401161807161108120 10408060101061418010 90108150
 F2080001061302050613100101081 6140 104080716021 61 40415010512181501040412110608140503161 40
 403150602131 406161 214021 40106131 6110 218110317121 80608161208130313140 21616120
 F6031008140402131008000404031 61 20 8121 10 8140 51 4030 502061304020 40 81
 30 404061 30 71 818161 80618120 71 815041816161 3181 803140504050 4021
 F3030308001908010300101803010305090801050301010302121808030801080803001318010805001100130209020808090
 80805080308080102030012080202010 0103001102010101050308080803010808060102101200180015010 030019080
 F1090802080105020502190900120802021112080213020211060010180102020208080015021019080209080108090202001
 30302010803190208080808021101020 300190208020200120801020011031311030203120508021902130 10802060
 F3180903090309080805010012040018030213010206050808080503120801001901150200110603050315031010150303001
 501020219020902110905030308030 20202170210101201090201021202010 20301010804010212031 20201021
 F2050101121602190016000308090902020500170909010502030013050909020212001802020109030218021212190102110
 01907010 80302030 10802180 8050205030 308021010130 804020 70902070703020606080 50308070
 F8001207031502021208000100070 1031 80205001 20213021 6021 208010 4001600150010110
 310120500180011011 109010 20013190 6060508010 405090 50 318090 018080 0121012070 80
 3160
 F1110700150001030002000000001 50 0121 5001 10 2101 1021 212150 7090 20
 212111 21212020 500120 31 5001 2121803150 21 70 010101 805070 300160 01 01
 30
 c144114111314144410212414444444241444444111144441444441141440043414131441044112144114414414441111144
 c 4 44 4 1 4 4 3 44
 c314333433322551231133334544044542123224123412332333543454333422241422342445425121535224044213204132
 c33233333232323121111321113332223233333232232323233232333333222222222222222322333333333222

Table 3

Analysis of the responses by column.

C1	0-0	1-77	2-2	3-1	4-12 99	5-3	6-1	7-1	8-1	9-1					
C3	0-0	1-4	2-73	3-17	4-5 99										
C5	0-1	1-2	2-13	3-36	4-47 99										
C7	0-1	1-1	2-6	3-17	4-32 99	5-42									
C9	0-0	1-84	2-7	3-2	4-6 99	5-0	6-0								
C11	0-0	1-4	2-11	3-21	4-46 99	5-17									
C13	0-14 15-0	1-4 16-1	2-11	3-18	4-18 99	5-9	6-11	7-9	8-3	9-0	10-1	11-0	12-0	13-0	14-0
C16	0-29 15-0	1-17 16-0	2-26 17-0	3-5 18-1	4-7 19-0 99	5-4 20-0	6-6 21-0	7-1 22-1	8-2	9-0	10-0	11-0	12-0	13-0	14-0
C19	0-30	1-69			99										
C21	0-34	1-65			99										
C23	0-16	1-8	2-2	3-10	4-16 99	5-30	6-1	7-12	8-2	9-2					
C24	0-43	1-8	2-5	3-4	4-14 99	5-9	6-3	7-4	8-2	9-7					
C25	0-74	1-5	2-1	3-0	4-3 99	5-2	6-3	7-4	8-4	9-3					
C27	0-0	1-0	2-64	3-5	4-5 99	5-13	6-12								
C29	0-1	1-55	2-5	3-3	4-1 99	5-1	6-6	7-24	8-3						
C30	0-6	1-22	2-7	3-0	4-5 99	5-4	6-18	7-34	8-3						
C31	0-18	1-9	2-7	3-1	4-1 99	5-14	6-12	7-21	8-16						
C33	0-2	1-32	2-26	3-3	4-1 99	5-4	6-28	7-2	8-1	9-0					
C34	0-3	1-23	2-34	3-1	4-7 99	5-13	6-8	7-9	8-0	9-1					
C35	0-11	1-16	2-15	3-6	4-11 99	5-24	6-11	7-4	8-0	9-1					
C36	0-31	1-3	2-6	3-6	4-9 99	5-23	6-13	7-6	8-0	9-0	10-2				
C38	0-69	1-1	2-3	3-0	4-3 99	5-10	6-8	7-4	8-1	9-0	10-0				

[illegible]

APPENDIX C

Documents relating to the study of the projects

- C.1 Letter sent to the Directors of potential projects requesting their participation in the study.
- C.2 The study questionnaire.
- C.3 The interview schedule.

Appendix C.1

DEPARTMENT OF SCIENCE EDUCATION

UNIVERSITY OF WARWICK

From: P.F.Bullett

Rugby (0788) 2953

8 Springhill,
Barby Road,
Rugby,
Warwicks CV22 5PY
20th December, 1987.Case-Studies of Industrial and Applications Resources Initiatives

I am writing to ask if you, as , would be prepared to co-operate with the above research study.

For the past four years, I have been pursuing some research into materials produced by industrial companies relevant to teachers of Physics in school. Amongst other things, I have tried to identify what is available and have published my findings in a 'Resources Directory' produced by the ASE in 1985 as one response to the problem of the apparently small uptake of such materials by teachers.

As the final phase of the research, I am keen to make case studies of several impressive initiatives which have brought relevant examples of the applications of science from the industrial setting into school during this period. I plan to concentrate on the stimulus and motivation behind the projects, the experiences of the co-ordinators in establishing and evaluating their projects, their views as to how these might develop in the future and how they feel the continuing need to give teachers and pupils access to appropriate material can best be met in the longer term. A brief outline of the evolution and scope of the project will give context to the case study.

If you are willing to help in principle, may I please ask you to complete the brief questionnaire enclosed with this letter? This will enable me to plan the study in greater detail and to assemble much of the factual information about your project in advance.

The next step would be for me to send you a prepared list of questions covering various aspects of your project and experience. This would allow you to have notice of the main areas of interest and to assemble any data you felt relevant. I would then hope to spend about an hour interviewing you, recording on tape, and exploring issues which arose in the course of your replies. The tape would form the basis of an 'abstract' and summary of replies, and would not be quoted directly.

By adopting a scheme of mixed structured and free interview techniques, I hope to be able to identify common elements in these successful projects and by pooling experience, to indicate guide-lines for those responsible for producing or disseminating materials intended for Physics teachers in the future. In the first instance, the research will be produced as part of a thesis, though if it seems to make a useful contribution, I would hope to seek wider publication in due course.

I am conscious that you will have many demands on your time and hope that the strategy proposed will yield the maximum useful information for a minimum commitment on your part. If you have any questions or reservations which you would like to discuss with me before replying, please telephone me at home (Rugby (0788) 2953) or leave a message for me at school to contact you (Rugby School Science Laboratory (0788) 3536).

With my thanks for your help in this matter.

Appendix C.2Questionnaire for Case Studies
of Industrial and Applications Resources Initiatives

Initiative: Contact:.....

Telephone number:..... Status:.....

Address:

.....

Date initiative started:, 19

Date of first publications:, 19

Details of any articles, reviews etc. concerning the initiative. (If there are many, please select the ones which you consider most informative and authoritative. Any off-prints etc. which you could let me have would be most appreciated.)

.....

.....

.....

.....

By whom are the materials published?

How are the materials distributed/advertized?

.....

.....

If the project has a finishing date, please give it here, 19

Where would be a convenient place for the follow-up interview to take place?

.....

Please indicate if Tuesday or Friday afternoons at about 3pm would be convenient in principle.

Tuesday ☐ Friday ☐

If neither, please suggest a time which is good for you in general.

.....

Thank you for completing the questionnaire. I look forward to contacting you again later in the New Year with the list of 'prepared' questions.

Please use the enclosed s.a.e. to return this questionnaire to:

P.F.Bullett, 8 Springhill, Barby Road, Rugby, Warwick CV22 5PY

Appendix C.3

Questions for Case-Study Interviews

Commissioning the Project.

1. Did you approach an organisation or were you approached?
2. What stimulated you to become involved in the initiative?
3. Why was the project initiated at that particular time?
4. What need(s) did you identify?
5. Why did you choose to meet them in this way, using these materials?

Development of Materials.

1. How open and co-operative did you find industrial companies in providing the information you needed to produce the materials?
2. What were the successful methods you devised for finding teachers prepared to become involved in the initiative?
3. How did you best match teachers to their counterparts in industry and facilitate a fruitful liaison?
4. What difficulties did you experience in producing materials by this approach?
5. What difficulties did you experience in producing successful materials by this approach?

Design of the Materials

1. Is your material 'lesson ready', or do you expect teachers to abstract information from it to produce their own work-sheets etc.
2. Are your materials directed at a particular school subject and a particular age-range?
3. Is your material syllabus specific or intended for project work?
4. How do you establish the reading-age and conceptual demands of your material?
5. Do you specifically consider the implications of any sex, ethnic or cultural bias in your material?
6. What factors influence the format and graphic design of your materials?

Questions for Case-Study Interviews

7. How do you see teachers using your material in the class-room?
8. How do you ensure editorial conformity when there is more than one writer?
9. What factors determine pricing policy?

Evaluation.

1. Were you able to pretest your material?
2. Did you assess its reading age?
3. What feed-back did you receive about the materials from the users?

Advertising.

1. How do/did you make teachers in school aware of your materials?
2. How do/did you encourage teachers to use them?

Overview and the Future.

1. What do you see as the major factors which affect whether teachers will obtain and use IPRM?
2. Do you see a role for your materials in the new applications emphasis of Science and Physics GCSE examinations?
3. What lasting effects do you judge involvement in your project to have had on teachers' attitudes to IPRM?
4. What lasting effect do you judge the involvement in your project to have had on the attitudes of those working in the contact industries?
5. What do you see as the next phase in increasing teachers' awareness and use of IPRM nationally?

APPENDIX D

Documents concerned with the model for curriculum
resource diffusion and utilization of IRM

- D.1 A case-study of TASCs
- D.2 An evaluation questionnaire for IRM
- D.3 The evaluation questionnaire produced by NAIEC

AN APPROACH TO EVALUATING IRM
(INDUSTRIAL RESOURCE MATERIAL)

An outline of the structure and early findings of a research project initiated within TASCs (The Technology and Science Centre in Surrey) at the SATRO, University of Surrey, under the direction of Mike Goodfellow and Dr John Gilbert, Reader in Science Education at the University of Surrey.

This outline summary was written following a visit by the author to TASCs on Wednesday, 22nd July, 1987.

The project, which is funded by the SCSST, is designed to develop a "consultancy service" for teachers on the effective use of IRM (Industrial Resource Material). The consultancy service will indicate local teachers whom other teachers may turn to for advice on the use of IRM, and will provide a local support mechanism for the use of NERIS (National Educational Resources Information Service).

The project directors decided at an early stage that the establishment of a collection of resource materials was not the way forward, because: it was hoped that others already working in the field of resource/teacher centres would develop this area, they had reservations about the use which teachers would make of such a collection, and foresaw inevitable problems of organization and staffing. Instead, they felt that teachers needed access to reliable evaluations of IRM by fellow teachers, and they set about establishing a consultancy service to provide them.

By September of 1986 some 20 teachers had been identified as willing to help with evaluations. Some had been involved in the national survey of IPRM outlined above (DICKER 1985) and others were drawn in through contact with the Surrey

SATROs many other activities. The SATRO obtained (purchased if necessary) the IRM chosen by the teacher concerned, who then evaluated it in use in his or her own school. (The term IPRM was modified to IRM to allow the inclusion in the study of any industrial material produced by 'companies whose main function is not the publishing of educational material'. This clearly encompasses all IPRM, but also includes material generated by joint projects with industry.) Teachers were offered a small financial reward in the form of an honorarium paid for each evaluation undertaken. The results of the evaluation were written onto an IRM record sheet, the format of which has continued to evolve as the project has developed. An example of the IRM record sheet as at May, 1987 is shown in Appendix 6.

Apart from objective information about the IRM and the evaluator, the sheet asks: how the resource was used, with whom, to what effect and whether the evaluator would use it again; whether the evaluator would recommend its use with other age groups, in other curriculum areas, in cross curricular activity; and the evaluator's opinion as to its particular usefulness, limitations, modifications necessary for more effective use and any special support needed to realise its potential.

These sheets will form the basis of the evaluation service, and when more than one teacher has evaluated a particular resource, a profile of its use and effectiveness will be built up.

The project directors feel that one of the most successful aspects of the project so far has been a residential, week-end conference for themselves, the twenty teacher-evaluators and Tim Morris, a representative from British Petroleum's Educational Relations section, held in a hotel in Bournemouth in March, 1987. The purpose of the

conference was 'to bring together teachers who had been involved in evaluating IRM ... to share their experiences on the availability, and effective use, of IRM to develop a model for a Consultancy Service on the effective use of such resources in schools' (ANSELL 1987).

Three specific questions were posed for consideration by the conference:

1. What are the characteristics of good IRM?
2. How do we use and appraise IRM?
3. What are the characteristics of a good consultancy service and how should it be developed?

Points emerging from the discussion of these questions (as listed in the Conference Report, ANSELL 1987) include:

1. Presentation should be:

stimulating (attractive format, good diagrams/animations, posters/cartoons, videos etc.), topical and reproducible,

and it should provide interest/stimulation, information, key lessons, activities for teachers to build upon and for homework, up-to-date pictures etc, not found in textbooks and for cross curricular links.

2. Teachers judged IRM's:

relevance (was it meant for school use?, is it educational/promotional?, bias, background),

excitement (challenge to pupils, pupil involvement, will pupils like it?),

design (relationship between text and graphics, layout),

appropriate use (language, support needed, introduction or revision).

They identified the following considerations which agencies producing IRM ought to bear in mind:

cost, storage, robustness, safety, long-term use (e.g. replacement of consumables),

accuracy, ease of use, language level, different levels of ability amongst students, definition of target groups,

level of teacher-support required, back-up material required, whether it is a stand-alone package or a modular course, how it might fit into schemes of work,

making material interactive (not passive), structuring it so it can be used in parts, explaining and repeating new words and ideas, designing software to be 'user-friendly'.

3. Characteristics identified as important included:

an evaluation sheet of a maximum of two sides of A4, to be completed by a teacher following use of the IRM with students;

a 'need - request - response' model should be set up under a co-ordinator, who would respond via a NERIS-type system in due course, but using paper as well, pro tem.;

evaluation must be refined in the light of experience, but must remain unbureaucratic and unbulky;

The need for a central SATRO IRM adviser: a teacher (or one who knows about teaching) with industry links to act as a sales person to schools; could be a team;

The need to establish a physical resource centre so the central adviser had ready access to good IRM to show teachers, but not a supermarket for all;

INSET needed so teachers can learn; what IRM is, how to find it, to use it effectively, to use evaluation, how to provide feedback to the companies who produce IRM;

IRM producers should: receive more feedback from teachers; be encouraged to consult with teachers, the consultancy service, other companies; to fill gaps in IRM to meet the needs of students and teachers; and to be involved in INSET.

The teachers found the conference valuable, particularly sharing their experiences with others, but as with some of the projects described in the case-studies, the other pressures under which teachers work have made it difficult for the project directors to keep teachers focused on IRM.

Having generated interest and enthusiasm amongst the original group of teacher-evaluators, it is hoped to use these teachers to train others in evaluation using a cascade model, perhaps at week-end conferences.

One factor which is likely to determine the use teachers will make of a consultancy service is the availability in schools of the technology required to access the data-bases, and an atmosphere in which its use is encouraged. The project directors hope to attract funding for a research study in the new year to look at the resource implications of using NERIS or a similar system. These might include: modems, BT telephone-line access and charges, subscriptions to PRESTEL and TTNS, and teachers' attitudes to the technology.

Companies are interested in these initiatives, because they are aware that they need greater feed-back from teachers about their materials and they wish to get 'maximum value for money' from their publications by encouraging good practice. One significant aspect of the consultancy could be both to provide general guidance for producers of IRM in the light of the experience gained from collating evaluation sheets and co-operating with industry to produce a separate work-book, which would accompany IRM, to help teachers make the best use of it.

Education authorities are enthusiastic about the possible establishment of a consultancy - especially with the specific demands the GCSE examinations will make of IRM - but have not so far been in a position to fund the work because of other priorities. It might also be necessary to devise some mechanism for charging the high proportion of independent schools in the SATRO area for use of the consultancy.

The Consultancy Service to promote the effective use of Industrial Resource Material in schools/colleges.

IRM Record

Resource information

1. Title of resource:
2. Author:
3. Is this part of a series? - if so, please give outline details of full series:
4. Target group (if any) Age: Ability:
5. Publisher: Date of publication:
6. Availability: Address:

 Telephone number:

 Type of availability (ie, sale, hire, etc):

 Price:
7. Brief Description of the Resource:

Evaluation of Resource

8. How did you use this resource? (including curriculum area)
9. With Whom?
10. To what effect?
11. Will you use it again, and if so, how?
12. Would you recommend that this resource is used:
 - a) with other age groups? If yes, please specify:
 - b) In other curriculum areas? If yes, please specify:
 - c) In cross curricular activity?
 - d) What is its particular usefulness?
 - e) What are its limitations?
 - f) What modifications to the resource are required for more effective use?
 - g) What special support does it currently need in order to realise its potential?
13. The name of the teacher evaluating this resource:
14. School/College:
15. Address:
16. Telephone number:
17. Date of Evaluation:

Appendix D.3

A GUIDE FOR EVALUATING INDUSTRY-SPONSORED EDUCATIONAL MATERIALS

INTRODUCTION

For some time, industry trade associations and non-profit organizations have been producing supplementary materials for use in our nation's schools. Properly planned, sponsored educational resources serve a valuable role and are particularly effective in giving information to students in an area where the sponsoring organization has achieved a high degree of specialization. When appropriately designed, sponsored resources can be used to motivate students and direct their energies into productive channels of growth.

This guide is an effort by the National Association for Industry Education Cooperation (NAIEC) to present teachers with an instrument for evaluating sponsored educational resources. These supplementary materials may take the form of teacher guides, filmstrips, games actually designed for the classroom or pamphlets, reprinted articles, annual reports which may provide valuable background information but are not developed specifically for the teacher's use. We suggest this guide is more effective with the former.

If, after completing your evaluation of those items designed for the classroom, you have no further use for the instrument, the sponsoring organization providing the item would appreciate your evaluation with any comments you might have for guidance in the development of future materials. Hopefully, this will foster closer industry education cooperation.

NAIEC was established in 196(?)4 as a means of mobilizing the resources of education and industry to improve the relevance and quality of educational programs at all levels. The organization grew out of the Business Industry Section of the National Science Teachers Association organized in the late 40s.

The Association appreciates the cooperation of participating members particularly those on the Teacher-Student Materials Committee and Drs Charles R DuVall and Wayne Krepel of Indiana University at South Bend who gave invaluable guidance to the project.

December, 1976.

National Association for Industry-
Education Cooperation,
235 Hendricks Boulevard,
Buffalo, NY 14226

A GUIDE FOR EVALUATING INDUSTRY-SPONSORED EDUCATIONAL MATERIALS

Title of material..... Date produced if available

Sponsor (name of organization)

Type of material Audio Audio Visual Printed Other

Type of instruction suitable for this material Individual Group

This evaluation is based on usage in (Grade level)

Evaluator Date

Subject area School

Address

.....

Instructions for use

Use the following scale for evaluating the material as it relates to your situation. Each of the descriptive statements is followed by a scale of (1) (2) (3) (4) (5). Indicate your assessment of the material by circling the appropriate number on the scale.

- (1) Definitely yes
 (2) Yes
 (3) No

- (4) Definitely no
 (5) Materials cannot be assessed on this concept

OBJECTIVES

Scale

Identified outcomes may be obtained through use of the material

1 2 3 4 5

The materials are representative of the curriculum involved, that is, they help further the objectives of the curriculum

1 2 3 4 5

ABILITY RANGE

The materials provide for the range of abilities and aptitudes of all pupils

etc.

CONTENT

The material is contemporary

The material is controversial

The material presents alternative views

CONTENT (Continued)

Scale

The material does not present a bias for a product, organization or social cause	1	2	3	4	5
The material does present a bias for a product, organization or social cause					etc.
If such bias exists, it does invalidate the material for my purposes					
The nature and scope of the material content is adequate to meet the curriculum objectives					
The material is supplementary to the curriculum					
The material correlates with a specific discipline area					
The material introduces experiences that would not otherwise be available in the classroom					
The material suggests other resources, supplementary and/or instructional					

UTILIZATION CHARACTERISTICS

The anticipated time utilization is commensurate with anticipated value of outcome
The material demands special conditions for use
The material is appropriate for students' reading level
The material is appropriate for students' interest level
The material is attractive to students
The material provides motivation for students

PRESENTATION OF MATERIALS

Provisions are made for evaluating the material as it is used within the educational program
Instructional procedures are outlined
The style of the presentation is likely to lead students toward accomplishing basic goals
Sample student activities are clearly stated
The intended use is easily understood
The production quality of the materials is acceptable

EVALUATION

The material provides for feedback to the user
The material provides for self-evaluation

BIBLIOGRAPHY

BOOKS AND ARTICLES

- ADELMAN, JENKINS & KEMMIS 1977
'Rethinking case-study: notes from the second Cambridge Conference' C Adelman, D Jenkins and S Kemmis, Cambridge Journal of Education 6 1977, p.139-150.
- ALDCROFT 1982
'Britain's Economic Decline 1870-1980' in The British Malaise: Industrial Performance, Education and Training in Britain Today, Eds. G Roderick and M Stephens, The Falmer Press, London, pp.31-61.
- ALEXANDER & WHITTAKER 1980
Developments in PGCE courses, R Alexander & B Whittaker, Teacher Education Study Group, University of Leeds, pp.177.
- ANSELL 1987
Report of IRM Conference 20-22 March, 1987, B Ansell, TASCs, University of Surrey, Guildford.
- ASE 1971
Science and General Education, The Association for Science Education, Hatfield, pp.8.
- ASE 1973
Science for the 13-16 age group, The Association for Science Education, Hatfield, pp.23.
- ASE 1979A
Alternatives for Science Education: a consultative document, The Association for Science Education, Hatfield, pp.61.
- ASE 1979B
Resource-based Learning in Science, Ed. D Foster, The Association for Science Education, Hatfield.
- ASE 1981
Education through science: policy statement, The Association for Science Education, Hatfield, pp.56.
- ASE 1984A
Rethinking Science, An occasional paper concerned with the the teaching of science to 11-16 year-olds within a social context, Hatfield.
- ASE 1984B
Issues in Science Education: a bibliographic survey, KM Lillis and RW West, ASE, Hatfield, pp.344.
- ASMIT 1981
Applications of Science and Mathematics to Industry and Technology: Teachers' Resource Material, Ed. B Nicholl, Association for Science Education, Hatfield, pp.92.
- BAILEY 1986
'Trade Unions in the Classroom', C Bailey, Secondary Education Journal 16 (1) January 1986, p.11-12.

- BALL 1974
'Aids to School from the Chemical Industry', CJ Ball, MJ Frazer & B Haines, Educ in Chem 11 September 1974, pp.150-151.
- BALL & GORDON 1985
Employer Liaison with Schools. B Ball & A Gordon, Institute of Manpower Studies Report No.108, Brighton.
- BATES 1980
'The Industry/Education Unit', EB Bates, Educ in Chem May 1980, pp.8 & 9.
- BECK 1981
'Education, Industry and the Needs of the Economy', J Beck, Cambridge Journal of Education 11 (2) 1981, pp.87-106.
- BES 1983
Economic and Industrial Awareness in the School Curriculum. Bedfordshire Education Service, Bedford.
- BEVAN 1984
'National Education Resources Information Service: A Computerised System available to schools', A Development Paper, DJ Bevan, DTI/SSTF, November (unpublished).
- BP 1981
'Resources for All from BP', D Barnet, View 9 Autumn 1981, pp.8 & 9.
- BRENNAN 1977
'The Great Debate: Some personal reflections', EJT Brennan, The Vocational Aspect of Education 29 (74) Autumn 1977, pp.99-101.
- BROWN 1985
Goldmine - Resources for Teachers. D Brown, BP/DTI, Epistemology, Worthing, pp.211.
- BULLETT 1985
A Directory of Physics Resource Materials. Ed. PF Bullett, The Association for Science Education, Hatfield, pp.22. (See Appendix A.7.)
- BURROUGHS 1971
Design and Analysis in Educational Research. GER Burroughs, Educational Monograph No.8, University of Birmingham School of Education.
- BUTLIN 1987
'What can and have the new initiatives such as TVEI offered for science education and physics in particular?', C Butlin, Transcription of a lecture delivered at the IoP Education Group's Conference in Brighton, April, (private correspondence).
- CALLAGHAN 1976A
'Great Educational Debate', Times Educational Supplement 1 October p.5, 22 October pp.1,2 & 3, 19 November 1976, p.18.
- CALLAGHAN 1976B
'Towards a national debate', J Callaghan, Education 148 22 October 1976, pp.332-33.
- CLEGG 1976
'It's the same old story', Sir A Clegg, Times Educational Supplement 22 October p.2.

- COHEN & MANION 1985
Research Methods in Education (Second Edition),
 L Cohen and L Manion, Croom Helm, Dover, New
 Hampshire, pp.383.
- COOK 1979
 'The Great Debate Continues', T Cook, History of
 Education Society Bulletin 23 Spring 1979,
 pp.52-55.
- COOMBES, LAZONBY & WADDINGTON 1983
 'Industrial Topics in School Chemistry',
 SD Coombes, JN Lazonby & DJ Waddington, Educ Chem
 20 (3) May 1983, pp.93-95.
- COOPER 1981
School-Industry Link Schemes: A Study and
 Recommendations, N Cooper, DES, HMSO
- CURTIS 1952
Education in Britain Since 1900, SJ Curtis, Andrew
 Dakers, London, pp.317.
- DAVIDSON 1970
Outdoor Recreation Surveys: The design and use of
 questionnaires for site surveys, J Davidson,
 Countryside Commission, London.
- DAVIES & FOREMAN 1982
 'Progress Through Partnership', R Davies and
 K Foreman, Inspection and Advice 16 Spring 1982,
 pp.10-11.
- DES 1976
School Education in England: Problems and
 Initiatives, DES Memorandum to the Prime Minister
 (The 'Yellow Book'), July 1976, DES, HMSO, pp.63.
- DES 1977A
Education in Schools: a consultative document, DES
 and Welsh Office, Cmd 6869, HMSO
- DES 1977B
Educating Our Children: Four subjects for debate.
 A background paper for the regional conference:
 February and March 1977, DES, HMSO.
- DES 1978
School examinations: Report of the Steering
 Committee established to consider proposals for
 replacing the GCE 'O'-level and CSE examinations
 by a common system of examining, (Waddell Report),
 Cmd 7281-I/II, DES, HMSO.
- DES 1980
A Framework for the School Curriculum: proposals
 for consultation by the Secretaries of State for
 Education and Science and for Wales, DES & Welsh
 Office, HMSO, pp.7.
- DES 1981
The School Curriculum, DES & Welsh Office, HMSO,
 pp.20.
- DES 1984
AS levels proposals by the Secretaries of State
 for Education and Science and for Wales for a
 broader curriculum for A-level Students, DES and
 Welsh Office, HMSO, pp.8.

- DES 1985A
Technology and School Science, an HMI enquiry.
DES, HMSO.
- DES 1985B
Science 5-16: a statement of policy. DES, HMSO.
- DICKER 1985
The use of Industrially Produced Resource Materials in School Science and Mathematics Teaching. R Dicker, University of Surrey, Roehampton Institute and the DTI, pp.87.
- DOE 1985
Initial Training of Teachers: Preparation for Industry Year 1986: report of a conference held in Oxford, Royal Society for the encouragement of Arts, Manufacturers and Commerce, London.
- DONALDSON 1982
Industry and Scottish Schools. a summary of a study, G Donaldson, Scottish Council Development and Industry, Edinburgh, pp.21.
- DTI 1977
Industry, Education and Management - A Discussion Paper. Department of Trade and Industry, HMSO.
- EBS 1982/3
1983/4
1984/5
A Survey of Listening in UK Schools. Annual Report, Education Broadcasting Services Research Unit, BBC, London;
B Survey of Viewing in UK Schools. Annual Report, Education Broadcasting Services Research Unit, BBC, London.
- EBS 1985
A Survey of Listening in UK Schools. Autumn, Education Broadcasting Services Research Unit, BBC, London;
B Survey of Viewing in UK Schools. Autumn, Education Broadcasting Services Research Unit, BBC, London.
- EBS 1986
A Survey of Listening in UK Schools. Spring, Education Broadcasting Services Research Unit, BBC, London;
B Survey of Viewing in UK Schools. Spring, Education Broadcasting Services Research Unit, BBC, London.
- EDGLEY 1977
'Education for Industry', R Edgley, Ed Research 20 (1) 1977, pp.26-32.
- EDWARDS & LLOYD 1981
An Evaluation of the Currency of the Concurrent Sandwich Degree and Certificate in Education; P Edwards and G Lloyd, Occasional Paper, Science and Technology Centre, University of Bath.
- EMMS 1981
'HMC Schools and British Industry', D Emms, An HMC Discussion Document, HMC, London, pp.68.
- FINANCE AND AWARDS 1979
Finance in Finance and Awards 1979 Volume 5. Department of Education and Science, HMSO.

- GASS 1982
Gas Applications for School Science: Resource Materials for Teachers, Gen. Ed. B Nicholl, British Gas Education Service / The Association for Science Education, London and Hatfield, pp.292.
- GCSE 1985
General Certificate of Secondary Education: The National Criteria: General Introduction, Science, Physics, DES/Welsh Office, London, HMSO.
- GCSE 1986
Science GCSE - A Guide for Teachers, The Secondary Examination Council and The Open University Press, Milton Keynes, pp.80.
- GCSE 1987
The Sciences: Double Award, Draft GCSE National Criteria, DES/Welsh Office, London, HMSO.
- GOULD 1987
 Private communication to the author from MJ Gould, May 1987.
- GOWING 1978
 'Science, technology and education in England in 1870', M Gowing, Oxford Review of Education 4 (1) 1978, pp.3-17.
- GRUBB & LAZERSON 1981
 'Vocational Solutions to Youth Problems: The Persistent Frustrations of the American Experience', WN Grubb and M Lazerson, Educational Analysis 3 (2) 1981, pp.91-103.
- GUARDIAN 1986
 'The appliance of science', M O'Connor, Guardian 9 September 1986, p.11.
- HAMILTON 1982
 'Education, Industry and Society', 26th Graham Clark Lecture, Sir James Hamilton, Council of Engineering Institutions, London, pp.30.
- HARTLES 1986
 'Week by week', R Hartles, Education 168 (14) 1986, p.287.
- HAYGARTH 1982
 'After Emms', R Haygarth, Conference 19 (1) February 1982, pp.24-25.
- HILL & HOLMAN 1978
Chemistry in Context, GC Hill & JS Holman, Nelson, London.
- HOLLOWAY 1975
 'Resources for Learning', M Holloway, pp.125-134 in Resources and Resources Centres, Eds. J Walton & J Ruck, Ward Lock Educational, London, pp.171.
- HOLMAN 1986
 'School science meets the real world', J Holman, New Scientist 13 February 1986, p.45.
- HOLMES 1981
 'Is school-industry liaison a liaison Dangereux?', S Holmes, Education 157 April 1981, pp.373-74.

- ICI 1981
'Schools Liaison at ICI', R Finch. View 8 Summer 1981. pp.4-6.
- IoP 1983
'Aiding school science', Physics Bulletin 34 January 1983, p.8.
- JAMIESON 1982
'Evaluation and SCIP', I Jamieson, Cambridge Journal of Education 13 (2) Easter Term 1982. pp.37-45.
- JAMIESON 1985
Industry in Education: developments and case studies. Ed. I Jamieson, Schools Council, Longmans, Essex.
- JAMIESON & LIGHTFOOT 1981
'Learning about work', I Jamieson & M Lightfoot, Educ Anal 3 (2) 1981. pp.37-51.
- JAMIESON & LIGHTFOOT 1982
Schools and Industry. Schools Council Working Paper 73. I Jamieson & M Lightfoot, Methuen Educational, London. pp.250.
- JONATHAN 1982
'Two Concepts of Education?', RM Jonathan. Journ Phil Educ 16 (2) 1982. pp.147-154
- JONATHAN 1986
'Education and "The Needs of Society"', RM Jonathan, in Education and Society Today: Contemporary Analysis in Education Series 13, Falmer Press, London. pp.135-145.
- KEIGHLEY & MCKIM 1965
The Physical World (III Volumes). J Keighley and FR McKim, Wheaton & Co., Oxford.
- KEMP 1985
'Is what you teach about industry really relevant?', R Kemp, Teaching Geography 10 (2) January 1985. pp.54-55.
- KENNY & GROTELUESCHEN 1984
'Making the case for case-study' WR Kenny and AD Grotelueschen Journal of Curriculum Studies 16 January 1984. p.37-51
- KIRTON 1984
Survey on schools, pupils and the engineering profession. The Engineering Council, London.
- LAKOMSKI 1987
'Case study methodology and the rational management of interaction' G Lakomski Educational Management and Administration 15 2 Summer 1987. p.147-157.
- LAMBERT, BULLOCK & MILLHAM 1975
The Chance of a Lifetime? R Lambert, R Bullock and S Millham, Weidenfeld and Nicholson, London.
- LEAF 1986
'Industry and Education in Partnership'. M Leaf, Training Officer May 1986. pp.145-48.

- LEAG 1986A
Science (Combined Biology, Chemistry and Physics)
Double Certification GCSE Syllabus. London and
 East Anglian Group for GCSE Examinations, London &
 Colchester.
- LEAG 1986B
Science (Syllabus N) for Double Certification.
 London and East Anglian Group for GCSE
 Examinations, London & Colchester.
- LEECH 1985
 'Education about Industry in a One Year PGCE
 Course', P Leech in Industry in Education:
development and case studies. Ed. I Jamieson,
 Schools Council, Longmans, Essex.
- LEESON 1982
School/Industry Links and Curriculum Development.
 P Leeson, The Building Societies Association,
 London.
- LEWIS 1980
 'Industry's social role', JL Lewis, Ed in Chem 17
 (3) 1980, pp.75-76.
- LLOYD 1978
 'A Corporate Venture - Chemical Industry and
 Education', G Lloyd, Educ in Sci 76 January 1978,
 pp.16-17.
- LLOYD 1984
 'A model for the development by industry and
 commerce of multi-media packs for use in
 education', G Lloyd, Program Learn Educ Technol 21
 (2) May 1984, pp.130-35.
- LLOYD JONES 1986
 'Week by Week', G Lloyd Jones, Education 21
 February 1986, p.159.
- MACLURE 1986A
 'An audit of a nation', JS Maclure in Times
Educational Supplement 11 April 1986, p.4.
- MACLURE 1986B
Educational Documents England and Wales: 1816 to
the present day. 5th Edition, JS Maclure, Methuen,
 London and New York.
- McKIM 1980
 'Chairman's key-note speech', FR McKim in The
SCSST's Report of the Autumn Conference 29 October
1980. Institute of Mechanical Engineers, London.
- McKIM 1983
 'The Physics Plus Project', FR McKim, Phys Educ 18
 1983, pp.221-224.
- MADDISON 1977
 'Phases of Capitalist Development', A Maddison,
Banco Nazionale del Lavoro Quarterly Review 121
 June 1977.
- MADDISON 1979
 'The Long Run Dynamics of Productivity Growth',
 A Maddison, Banco Nazionale del Lavoro Quarterly
Review 128 March 1979.

- MARSDEN 1983
What Industry Really Wants: Implications for Education and the Community. CL Marsden, British Petroleum (mimeo), London.
- MASON 1984
Free and Cheap Resources for Schools: a survey and guide. RS Mason, Library Association Publishing, London.
- MEG 1986A
'Combined Science' syllabus for GCSE 1988. Midlands Examining Group.
- MEG 1986B
'Physics' syllabus for GCSE 1988. Midlands Examining Group.
- METHUEN 1976
'What Industry Wants', Sir J Methuen, Times Educational Supplement 29 October 1976, p.2.
- MILLAR 1979
'The Power Station Game: A Study', JWL Millar, Phys Educ 14 (1) January 1979, pp.34-37.
- MOBLEY 1985
Evaluating Curriculum Materials: An Introduction. M Mobley, Longman Research Unit for SCDC, pp.31.
- MARONEY 1953
Facts from Figures. 2nd Edition (reprinted 1965). MJ Moroney, Penguin Books, Harmondsworth, Middlesex.
- MUDIE 1982
'Education and Industry: A Study of Developments in the Relationship between Education and Industry since 1960', RC Mudie, unpublished M.Ed. thesis, University of Dundee.
- NAE, HOFSTEIN & SAMUEL 1982
'The case for case studies - school chemistry and the chemical industry', N Nae, A Hofstein and D Samuel, Educ Chem 19 (1) January 1982, pp.20-21.
- NAIEC 1976
'A Guide for Evaluating Industry-Sponsored Educational Materials', National Association for Industry-Education Co-operation, Buffalo, NY, pp.4.
- NCST 1976
A Directory of Resource Materials for teachers of technology in schools. Ed. CJ Pratt, No 2 December 1976, NCST/SCSST, Trent Polytechnic, Nottingham.
- NEA 1986A
'Science (Modular)' syllabus for GCSE 1988. Northern Examining Association.
- NEA 1986B
'Physics Syllabus B' for GCSE 1988. Northern Examining Association.
- NFER 1976
The Dissemination of Curriculum Development. J Rudduck and P Kelly, Eds. J Wrigley and F Sparrow, NFER Publishing, Windsor, for The Council of Europe.

- NICHOLAS 1985
 'Technical Education and the Decline of Britain, 1870-1914', SJ Nicholas, in The Steam Intellect Societies - Essays on Culture, Education and Industry circa 1820-1914, Ed. I Inkster, Dept. Adult Education, University of Nottingham.
- NICHOLL 1982
 'Physics of Technology or Both?', B Nicholl, Phys Educ 17 (2) March 1982, pp.67-79.
- NISBET & WATT 1980
Case Study J Nisbet and J Watt, Rediguide 26: Guides to Educational Research, Nottingham University School of Education, pp.24.
- O'BRIEN 1977
Education, Industry and People. R O'Brien, University of Birmingham, 1977.
- O'CONNOR 1982
 'Two Concepts of Education', DJ O'Connor, Journ Phil Educ 16 (2), pp.137-146.
- OLSON 1980
 'Innovative doctrine and practical dilemmas: a case study of curriculum translation', JK Olson, unpublished Ph.D. thesis, University of Birmingham.
- OVERTURE 1985
'Study of Resources' and 'Overture': Working Paper and Progress Report. RH Gammon, IEU/DTI and Southern Science and Technology Forum, Southampton.
- OVERTURE 1986A
Action Plan and Progress Report on 'Study of Resources' and 'Overture'. IEU/DTI and Southern Science and Technology Forum, Southampton.
- OVERTURE 1986B
Resources Package: 'Overture' - Information and Examples, IEU/DTI and Southern Science and Technology Forum, Southampton.
- OVERTURE 1986C
Final Report on 'Study of Resources' and 'Overture'. IEU/DTI and Southern Science and Technology Forum, Southampton.
- PAGE 1981
 'An attitude scale for technology', R Page, M Orr and M Nash, Res Educ 26 November 1981, pp.55-63.
- PAGE & NASH 1980
 'The Teenage Viewpoint: attitudes to Technology and Industry', RL Page and JMU Nash, Sch Technol 14 (2) December 1980, pp.12-13.
- PHYSICS AT WORK 1980A
'Physics at Work': A Resource Book for Teachers. Ed. B Nicholl, BP Educational Service / The Association for Science Education, Hatfield.
- PHYSICS AT WORK 1980B
A Guide to a Schools/Industry Project: Planning and Organisation, BP Educational Service / The Association for Science Education, Hatfield.

PILKINGTON 1978

'Relationships between science, education and industry', Sir A Pilkington, Presidential Address to The Association for Science Education at its Annual Meeting, School Science Review 59 (209) June 1978, pp.591-603.

RAE 1977

'Our Obsolete Attitudes: Education and the National Malaise', J Rae, Encounter November 1977, pp.10-17.

RAITT 1987A

Private communication to the author from JG Raitt, 15 May 1987.

RAITT 1987B

Forces: Building a cantilever bridge. JG Raitt, 'Physics in Action' series, Cambridge University Press, pp.57.

REEDER 1979

'A Recurring Debate: Education and Industry', D Reeder in Schooling in Decline. Ed. G Bernbaum, Macmillan, London.

REID 1980

'Understanding chemical industry - teaching materials', N Reid, Educ in Chem 17 (3) May 1980, pp.78-80.

RICHMOND 1970

An Introduction to Piaget. PG Richmond, Routledge & Kegan Paul, London.

RODERICK & STEPHENS 1981

Where did we go wrong? Industry, Education and Economy of Victorian Britain. Eds. G Roderick and M Stephens, The Falmer Press, Sussex.

RODERICK & STEPHENS 1982

The British Malaise: Industrial Performance, Education and Training in Britain Today. Eds. G Roderick and M Stephens, The Falmer Press, Sussex.

ROLF 1981

'Education and Industry: the Malcolm Committee', D Rolf, Oxford Review of Education 7 (1) 1981, pp.95-106.

ST JOHN-STEVAS 1978

'The Government's Green Paper', N St John-Stevas, Oxford Review of Education 4 (1) 1978, pp.19-26.

SALTERS 1987

Salters Chemistry (to be published in 1987), Science Education Group, Department of Chemistry, University of York.

SATIS 1986

Science and Technology in Society - General Guide for Teachers, J Holman, Association for Science Education, Hatfield.

SCDC 1986

Databases for Education - a directory of computerised information sources in education. School Curriculum Development Committee, London.

SCDC 1987A

Evaluating Curriculum Materials. M Mobley. Longman Resources Unit for SCDC, York and Essex.

SCDC 1987B

Work Experience Workbooks: A critical review. I Jamieson, B Newman and J Peffers. Longman Resources Unit for SCDC, York and Essex.

SCDC 1987C

Industry in Education: Developments and case studies. Ed. I Jamieson, Longman Resources Unit for SCDC, York and Essex.

SCHOOLS COUNCIL 1974

Dissemination and in-service training. Report of the Schools Council Working Party on Dissemination 1972-73, Schools Council.

SCSST/ASE 1985

Experimenting with Industry. Standing Conference on Schools' Science and Technology and The Association for Science Education, London and Hatfield.

SCOTT, SELMES & SMITH 1984

Student Teachers at Work: An Evaluation of the Course 'Initial Teacher Education and The World of Work'. WAH Scott, C Selmes and B Smith, Ed. G Hones, An Occasional Publication of The School of Education, University of Bath.

SCOTT & LLOYD 1979

An Evaluation of BP's Resource Book - 'A North Sea Adventure'. J Scott and G Lloyd, An Occasional Paper, Science and Technology Centre, University of Bath.

SCREEN 1981

Industrial Experience within the PGCE. PA Screen, Department of Science Education, University of Warwick.

SEC 1986

Science GCSE: A Guide for Teachers. Secondary Examinations Council and The Open University, Milton Keynes, pp.80.

SEG 1986

A Teachers' Guide: GCSE Physics. Southern Examining Group.

SEO 1983

Key Issues for Industry and Education. Society of Education Officers, Occasional Paper 3, London, pp.4.

SHARPE 1981

Study of GCE 'O'-level and CSE Examination Papers Set in Physics and Related Subjects. PJ Sharpe, Southern Science and Technology Forum.

SIS 1981

'Science in Society': A Sixth-Form General Studies Course. Ed. J Lewis, Heinemann Educational Books and The Association for Science Education, London and Hatfield.

SIS 1984

'Science in Society - What Next?'. A questionnaire in Education in Science (109) September 1984, pp.20-22.

SSCR 1987A

Better Science: Making it happen. M O'Connor, The Association for Science Education with Heinemann Educational Books, Hatfield and London, for the School Curriculum Development Committee.

SSCR 1987B

Better Science: A Directory of Resources. The Association for Science Education with Heinemann Educational Books, Hatfield and London, for the School Curriculum Development Committee.

STAKE 1975

The Case Study Method in Social Inquiry RE Stake, Centre for Applied Research in Education, University of East Anglia (mimeo), December 1975.

STATISTICAL BULLETIN 1986

Statistical Bulletin 8/86 May 1986, Department of Education and Science, HMSO.

STYAN 1986

'A critical study of the case for linking schools and industry', D Styan, Secondary Education Journal 16 (1) January 1986, pp.8-10.

SUDMAN & BRADBURN 1982

Asking Questions - a Practical Guide to Questionnaire Design. S Sudman and NM Bradburn, Jossey-Bass, San Francisco.

SYMONS 1987

Private communication to the author from R Symons, 7 September 1987.

TAYLOR 1986

'A teacher's guide to the learning resource jungle', D Taylor, Money Management Review. (17) Summer 1986.

TEACHERS IN SERVICE 1984

Statistics in Education: Teachers in Service England and Wales 1984. Department of Education and Science, HMSO.

TES 1976A

'Schools Council takes industry into the classroom', V Makins, Times Educational Supplement. 1 October 1976, p.5.

TES 1976B

'The Yellow Book', Times Educational Supplement. 15 October 1976, p.1-3.

TES 1980

'Engineering Market Place', B Hicks, Times Educational Supplement. 18 April 1980, pp.26-27.

TES 1986

'The Way it Ought to Be', V Makins, Times Educational Supplement. 28 November 1986, pp.24-25.

THORNTON 1978

'The Engineering Profession - a national investment'. Report of the Working Party set up by the Conservative Party under Prof. John Thornton, Conservative Political Centre, London.

- TIP 1985
Telecommunications in Practice: Resources for Science Teaching. Eds. B Nicholl and J Selfe, British Telecom and The Association for Science Education, London and Hatfield, pp.120.
- TREADGOLD 1977
'Industry and Education', SW Treadgold. Coombe Lodge Report 10 (4), pp.188-195.
- TURNER 1987
'Sixth formers' attitudes to industry', DW Turner, unpublished M.Ed. thesis, University of Warwick, pp.92.
- TYNDALE 1976
1 William Tyndale Junior and Infants School Public Inquiry. R Auld QC, ILEA, London, pp.309 + appendices.
2 William Tyndale 'Collapse of a school - or a system'?, J Gratton and M Jackson, Allen and Unwin, London, pp.126.
3 The Lessons of Tyndale - An Examination of the William Tyndale School Affair. P Williams, Conservative Political Centre, London, pp.16.
- UBI 1979
Teaching Materials: A guide to materials available from Industry and Commerce. Understanding British Industry, Oxford.
- UK EDUCATION 1967
Education Statistics for the UK 1967. Department of Education and Science, HMSO.
- UK EDUCATION 1986
Education Statistics for the UK 1986. Department of Education and Science, HMSO.
- UNILEVER 1982
'Learning from Unilever', View 11 Spring 1982, pp.12-13.
- WHITMARSH 1986
'False accusations fuelling the crisis', G Whitmarsh, Times Higher Education Supplement 6 June 1986, p.14.
- WIENER 1981
'English Culture and the Decline of the Industrial Spirit' 1850-1980, MJ Wiener, Cambridge University Press, pp.217.
- WILLIAMS 1976
'The Great Debate', Shirley Williams. Education 148 29 October 1976, p.342.
- WILSHIRE 1976
'Teachers welcome a debate - but in the open', A Wilshire, Education 148 22 October 1976, p.326.
- WITKIN 1975
'Teachers' perceptions of their needs for resources', RW Witkin, pp.75-93 in Resources and Resources Centres. Eds. J Walton and J Ruck, Ward Lock Educational, London, pp.171.
- WRAGG 1978
Conducting and Analysing Interviews. EC Wragg, Rediguide 11: Guides in Educational Research, University of Nottingham School of Education, pp.22.

YEOMANS 1987

'Checking and adjusting the lens: case study clearance' R Yeomans, Cambridge Journal of Education 17 2 Easter 1987, p.89-90.

YOUNGMAN 1978

Designing and Analysing Questionnaires. MB Youngman, Rediguide 12: Guides in Educational Research, University of Nottingham School of Education, pp.40.

GOVERNMENT REPORTS

BALFOUR 1929

Final Report of the Committee on Industry and Trade. Sir A Balfour, Cmnd. 3283, HMSO.

BRUNTON 1963

Report of the Working Party on the Linkage of Secondary and Further Education. JS Brunton, HMSO.

BULLOCK 1975

A Language for Life. Sir A Bullock, Report of the Committee of Inquiry appointed by the Secretary of State for Education and Science, HMSO.

DAINTON 1968

Enquiry into the flow of candidates in Science and Technology into Higher Education. FS Dainton, Cmnd. 3541, HMSO.

DEVONSHIRE 1875

Royal Commission on 'Scientific Instruction and the Advancement of Science'. William Cavendish, 7th Duke of Devonshire, HMSO.

FINNISTON 1980

Engineering our Future: report of the Committee of Inquiry into the Engineering Profession. Sir M Finniston, Cmnd. 7794, DTI, HMSO.

HOLLAND 1977

Young People at Work: report on the feasibility of a new programme of opportunities for unemployed young people. G Holland, Manpower Services Commission, HMSO.

HOUGHTON 1974

Committee of Inquiry into the pay of non-university teachers. Lord Houghton of Sowerby, Cmnd. 5848, HMSO.

JONES 1967

Committee on Manpower Resources for Science and Technology. FE Jones, Cmnd. 3417, HMSO, pp.136.

MALCOLM 1928

Report of the Committee on Education and Industry (England and Wales). DO Malcolm, HMSO.

NEWSOM 1963

Half our future. Sir JH Newsom, Central Advisory Council for Education, HMSO.

PERCY 1928

Report on Education for Industry and Commerce. ESC Percy, HMSO.

PLOWDEN 1967

Children and their primary schools. Lady Plowden,
A Report of the Central Advisory Council for
Education (England): Vol 1 The Report, pp.610, Vol
2 Research and Surveys, pp.640.

ROBBINS 1963

Committee on Higher Education, Lord Robbins, HMSO.

SAMUELSON 1882

Report of the Royal Commission on Technical
Instruction. B Samuelson, HMSO.

SWANN 1968

The flow into employment of scientists, engineers
and technologists. M Swann, Committee on Manpower
Resources for Science and Technology, Cmd. 3760,
HMSO.

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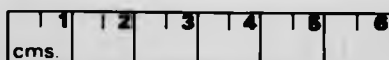
INDUSTRIALLY PRODUCED RESOURCE MATERIALS
FOR TEACHERS OF PHYSICS IN SCHOOLS

AUTHOR

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